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[Claim 1]

A network analyzer comprising:

measuring system error factor recording means for recordings measuring system error factors that are produced independently of frequency conversion by the device under test;

calibration coefficient outputting means wherein a signal that is outputted from a terminal is expressed as the sum of the product of a signal that is inputted to the terminal multiplied by first coefficient plus the product of a signal that is inputted into another terminal multiplied by a second coefficient, for outputting a measurement of the first coefficient and the second coefficient of a calibration frequency converting element wherein the ratio of the magnitude of the second coefficient is constant; and

transmission tracking acquiring means for acquiring a transmission tracking that is produced through frequency conversion based on the measuring system error factor that is recorded in the measuring system error factor recording means and the first coefficient and second coefficient outputted from the calibration coefficient outputting means.

[Claim 2]

A network analyzer as set forth in claim 1, wherein:

when, in the calibration frequency converting element:

the first coefficient is defined as M11' and M22',

the second coefficient is defined as M12' and M21',

a signal that is inputted into a first terminal is defined as a1 and a signal that is outputted from the first terminal is defined as b1, and

a signal that is inputted into a second terminal is defined as a2 and a signal that is outputted from the second terminal is defined as b2,

$b1 = M11' \times a1 + M12' \times a2$, and

$b2 = M21' \times a1 + M22' \times a2$; wherein

$|M12'| / |M21'|$ is a constant.

[Claim 3]

A network analyzer as set forth in Claim 1 or Claim 2, wherein:

the magnitude of the second coefficient is the same regardless of the terminal.

[Claim 4]

A network analyzer as set forth in any one of Claim 1 through Claim 3, comprising:

input signal measuring means for measuring an input signal parameter relating to an input signal that is inputted into the device under test, prior to the production of the measuring system error factor;

a plurality of ports, connected to a terminal of the device under test, for outputting the input signal; and

device-under-test signal measuring means for measuring a device-under-test signal parameter related to a device-under-test signal that is inputted into the port from the device-under-test terminal.

[Claim 5]

A network analyzer as set forth in Claim 4, wherein:

the calibration coefficient outputting means calculates the first coefficient and the second coefficient of the calibration frequency converting element through a ratio of the input signal parameter measured by the input signal measuring means and the device-under-test signal parameter measured by the device-under-test signal measuring means.

[Claim 6]

A network analyzer as set forth in Claim 4, wherein:

the transmission tracking acquiring means acquire the transmission tracking based on a ratio of an error factor that is produced between the device-under-test signal output that concomitant with the frequency conversion, from the device-under-test terminal, and the reception by the device-under-test signal measuring means.

[Claim 7]

A network analyzing method comprising:

a measuring system error factor recording process wherein measuring system error factor recording means record a measuring system error factor that is produced independently of frequency conversion by a measurement object;

a calibration coefficient outputting process wherein calibration coefficient outputting means output the measurements of a first coefficient and a second coefficient of a calibration frequency converting element wherein a signal that is outputted from a terminal expresses the sum of the product of a signal that is inputted into that terminal multiplied by the first coefficient plus the product of a signal that is inputted into another terminal multiplied by the second coefficient, and the ratio of the magnitude of the second coefficient is constant; and

a transmission tracking acquiring process wherein transmission tracking acquiring means acquire a transmission tracking that is produced through frequency conversion based on the measurement error factor recorded in the measurement error factor recording means and the first coefficient and second coefficient outputted by the calibration coefficient outputting means.

[Claim 8]

A program for causing a computer to execute:

a measuring system error factor recording process for recording a measuring system error factor that occurs independently of a frequency conversion by a measurement object;

a calibration coefficient outputting process for outputting the measurements of a first coefficient and a second coefficient of a calibration frequency converting element wherein a signal that is outputted from a terminal expresses the sum of the product of a signal that is inputted into that terminal multiplied by the first coefficient plus the product of a signal that is inputted into another terminal multiplied by the second coefficient, and the ratio of the magnitude of the second coefficient is constant; and

a transmission tracking acquiring process for acquiring a transmission tracking that is produced through frequency conversion based on the measurement error factor recorded in the measurement error factor recording means and the first coefficient and second coefficient outputted by the calibration coefficient outputting means.

[Claim 9]

A recording medium, readable by a computer, where on the is recorded a program for causing a computer to execute:

a measuring system error factor recording process for recording a measuring system error factor that occurs independently of a frequency conversion by a measurement object;

a calibration coefficient outputting process for outputting the measurements of a first coefficient and a second coefficient of a calibration frequency converting element wherein a signal that is outputted from a terminal expresses the sum of the product of a signal that is inputted into that terminal multiplied by the first coefficient plus the product of a signal that is inputted into another terminal multiplied by the second coefficient, and the ratio of the magnitude of the second coefficient is constant; and

a transmission tracking acquiring process for acquiring a transmission tracking that is produced through frequency conversion based on the measurement error factor recorded in the measurement error factor recording means and the first coefficient and second coefficient outputted by the calibration coefficient outputting means.

[Title of Document] Specification
[Title of the Invention] Network Analyzer, Network Analyzing Method, Program, and Recording Medium
[Field of Technology]
[0001]
The present invention relates to a network analyzer for calculating and measuring a circuit parameter of a measurement object.
[Prior Art]
[0002]
Conventionally, measurements have been performed on circuit parameters (for example, an S parameter) of an object to be measured (a "Device Under Test," "DUT"). The measurement method for the circuit parameter of the device under test (DUT) as set forth in the conventional technology will be explained in reference Fig. 25.
[0003]
A signal of a frequency f1 is sent from a signal source 110 to a receiving unit 120 from a signal source 110. This signal is received by the receiving unit 120. The frequency of the signal received by the receiving unit 120 defined as f2. The S parameter of the DUT 200, and the frequency characteristics, etc., can be acquired through measuring the signal that is received by the receiving unit 120.
[0004]
At this time, measurement error occurs in the measurement through, for example, the measuring system of the signal source 110, mismatch with the DUT 200, and so forth. This measuring system error is, for example, "Ed": error arising in directionality in the bridge, "Er": error arising in the frequency tracking, and "Es": error arising in source matching. A signal flow graph relating to the signal source 110 in the case wherein the frequencies f1 = f2 is presented in Fig. 26. RF IN is a signal that is inputted from the signal source 110 into the DUT 200, and the like; S11m is the S parameter of the DUT 200, and the like, calculated from the signal that is reflected from the DUT 200, or the like; and S11a is the true S parameter of the 200, or the like, with no measuring system error.
[0005]
When the frequencies f1 = f2, then the error may be corrected as described in, for example, Patent Reference 1. This correction is called "calibration." Calibration will be explained briefly below. A calibration kit is attached to the signal source 110 to achieve three different states: Open, Shorted, and Loaded (with a standard load of Z0). At this time, the signal that is reflected from the calibration kit is required by the bridge, and the S parameters (S11m) of these three types are calculated in accordance with the three different states. Variables Ed, Er, and Es are calculated from these three S parameters.
[0006]
However, in some cases a frequency f1 is not equal to the frequency f2. For example, there is the case wherein the DUT 200 is a device having a frequency converting function, such as a mixer. A signal flow graph pertaining to the signal source 110 for the case wherein the frequency f1 is not equal to the frequency f2 is presented in Fig. 27. Ed

and Es are the same as for the case wherein the frequency f1 is equal to the frequency f2, but Er is divided into Er1 and Er2. In the calibration as set forth in Patent Reference 1, only the three types of S parameters (S11m) are calculated, and so only Ed, Es, and the Er1· Er2 can be calculated. Thus it is not possible to calculate Er1 and Er2.

[0007]

Furthermore, when the frequency f1 does not equal the frequency f2, the measuring system error due to the signal receiving unit 120 cannot be ignored. A signal flow graph for the case wherein the signal source 110 and the signal receiving unit 120 are elected directly is presented in Fig. 28. S21m is a S parameter for the DUT 200, or the like, calculated from the signal received by the signal receiving unit 120. As is illustrated in Fig. 28, Et and EL measuring system errors are produced by the signal receiving unit 120. The calibration set forth in Patent Reference1 is also incapable of calculating these

[0008]

Given this, the error is corrected as set forth in Patent Reference 2 in the case wherein the frequency f1 does not equal the frequency f2. First the three types of calibration kits (Open, Shorted, and Loaded (with the standard load of Z0)) are connected to the signal source. This is identical to the method set forth in Patent Reference 1, and thus is able to calculate Ed, Es, Er1 · Er2. Next, the signal source is connected to a power meter. Er1 and Er2 can be calculated based on the power meter measuring results. (See Patent Reference 2, Fig. 6 and Fig. 7.). Furthermore, the signal source is connected directly to the signal receiving unit, enabling the calculation of Et and EL from the measuring results at that time. (Patent Reference 2, Fig. 8 and Fig. 9.)

[0009]

Note that the transmission tracking is defined as Er1 · Et . Because Er1 and Et can be calculated through the method set forth in Patent Reference 2, it is also possible to calculate the transmission tracking Er1 · Et.

[0010]

[Patent Reference 1] Japanese Unexamined Patent Application Publication H11-38054

[Patent Reference 2] International Publication 03/087856 pamphlet

[Disclosure of the Invention]

[Problem Solved by the Present Invention]

[0011]

However, when the transmission tracking Er1 · Et is calculated using the method set forth in Patent Reference 2, it is necessary to use a power meter in order to calculate Er1. Because the power meter is used, the phase of the transmission tracking cannot be acquired.

[0012]

Given this, the object of the present invention is to enable the correction of measuring system error through enabling the acquisition of the transmission tracking phase.

[Means for Solving the Problem]

[0013]

The present invention is structured from:

measuring system error factor recording means for recordings measuring system error factors that are produced independently of frequency conversion by the device under test; calibration coefficient outputting means wherein a signal that is outputted from a terminal is expressed as the sum of the product of a signal that is inputted to the terminal

multiplied by first coefficient plus the product of a signal that is inputted into another terminal multiplied by a second coefficient, for outputting a measurement of the first coefficient and the second coefficient of a calibration frequency converting element wherein the ratio of the magnitude of the second coefficient is constant; and transmission tracking acquiring means for acquiring a transmission tracking that is produced through frequency conversion based on the measuring system error factor that is recorded in the measuring system error factor recording means and the first coefficient and second coefficient outputted from the calibration coefficient outputting means.

[0014]

The invention structured as set forth above records the measuring system error factors that occur independently of the frequency conversion by the device under test. The calibration coefficient outputting means outputs that which has been measured for the first coefficient and the second coefficient of the calibration frequency converting element, wherein the ratio of the magnitude of the second coefficient is constant, where a signal that is outputted from a terminal expresses the sum of the product of a signal that is inputted into that terminal multiplied by the first coefficient plus the product of a signal inputted into another terminal multiplied by the second coefficient. The transmission tracking acquiring means acquires the transmission tracking that is produced through the frequency conversion based on the measuring system error factor recorded in the measuring system error factor recording means and the first coefficient and the second coefficient outputted by the calibration coefficient outputting means.

[0015]

In the present invention, preferably, when, in the calibration frequency converting element, the first coefficient is defined as M11' and M22', the second coefficient is defined as M12' and M21', a signal that is inputted into a first terminal is defined as a1 and a signal that is outputted from the first terminal is defined as b1, and a signal that is inputted into a second terminal is defined as a2 and a signal that is outputted from the second terminal is defined as b2, then

$b1 = M11' \times a1 + M12' \times a2$, and

$b2 = M21' \times a1 + M22' \times a2$; wherein

$|M12'| / |M21'|$ is a constant.

[0016]

Moreover, preferably in the present invention, the magnitude of the second coefficient is the same regardless of the terminal.

[0017]

Furthermore, the present invention preferably comprises: input signal measuring means for measuring an input signal parameter relating to an input signal that is inputted into the device under test, prior to the production of the measuring system error factor; a plurality of ports, connected to a terminal of the device under test, for outputting the input signal; and device-under-test signal measuring means for measuring a device-under-test signal parameter related to a device-under-test signal that is inputted into the port from the device-under-test terminal.

[0018]

Furthermore, in the present invention preferably the calibration coefficient outputting means calculates the first coefficient and the second coefficient of the calibration frequency converting element through a ratio of the input signal parameter measured by

the input signal measuring means and the device-under-test signal parameter measured by the device-under-test signal measuring means.

[0019]

Furthermore, in the present invention preferably the transmission tracking acquiring means acquire the transmission tracking based on a ratio of an error factor that is produced between the device-under-test signal output that concomitant with the frequency conversion, from the device-under-test terminal, and the reception by the device-under-test signal measuring means.

[0020]

The present invention is calibrated through the provision of a measuring system error factor recording process wherein measuring system error factor recording means record a measuring system error factor that is produced independently of frequency conversion by a measurement object; a calibration coefficient outputting process wherein calibration coefficient outputting means output the measurements of a first coefficient and a second coefficient of a calibration frequency converting element wherein a signal that is outputted from a terminal expresses the sum of the product of a signal that is inputted into that terminal multiplied by the first coefficient plus the product of a signal that is inputted into another terminal multiplied by the second coefficient, and the ratio of the magnitude of the second coefficient is constant; and a transmission tracking acquiring process wherein transmission tracking acquiring means acquire a transmission tracking that is produced through frequency conversion based on the measurement error factor recorded in the measurement error factor recording means and the first coefficient and second coefficient outputted by the calibration coefficient outputting means.

[0021]

The present invention is a program for causing a computer to execute: a measuring system error factor recording process for recording a measuring system error factor that occurs independently of a frequency conversion by a measurement object; a calibration coefficient outputting process for outputting the measurements of a first coefficient and a second coefficient of a calibration frequency converting element wherein a signal that is outputted from a terminal expresses the sum of the product of a signal that is inputted into that terminal multiplied by the first coefficient plus the product of a signal that is inputted into another terminal multiplied by the second coefficient, and the ratio of the magnitude of the second coefficient is constant; and a transmission tracking acquiring process for acquiring a transmission tracking that is produced through frequency conversion based on the measurement error factor recorded in the measurement error factor recording means and the first coefficient and second coefficient outputted by the calibration coefficient outputting means.

[0022]

The present invention is a recording medium, readable by a computer, where on the is recorded a program for causing a computer to execute: a measuring system error factor recording process for recording a measuring system error factor that occurs independently of a frequency conversion by a measurement object; a calibration coefficient outputting process for outputting the measurements of a first coefficient and a second coefficient of a calibration frequency converting element wherein a signal that is outputted from a terminal expresses the sum of the product of a signal that is inputted into that terminal multiplied by the first coefficient plus the product of a signal that is inputted

into another terminal multiplied by the second coefficient, and the ratio of the magnitude of the second coefficient is constant; and a transmission tracking acquiring process for acquiring a transmission tracking that is produced through frequency conversion based on the measurement error factor recorded in the measurement error factor recording means and the first coefficient and second coefficient outputted by the calibration coefficient outputting means.

[Most Preferred Form for Carrying out the Invention]

[0023]

An example of embodiment of the present invention will be explained below in reference to the figures.

[0024]

Fig. 1 is a block diagram illustrating the structure of a network analyzer 1 according to an example of embodiment according to the present invention. A DUT (device under test, or object to be measured) 2 is connected to the network analyzer 1. The network analyzer 1 measures a circuit parameter, such as the S parameter, of the DUT 2. Note that when a mixture (a multiplier) is used as the DUT 2, the S parameter is called the "M parameter," in particular.

[0025]

Fig. 2 (a) is a diagram illustrating the structure of the DUT 2. The DUT 2 is a mixture (a multiplier). The DUT 2 has a first terminal 2a, a second terminal 2b, an RF signal processing unit 2R, an IF signal processing unit 2I, and a local signal processing unit 2L.

[0026]

When a signal a1 of a frequency f1 is inputted from first terminal 2a, it is applied to the RF signal processing unit 2R. Additionally, a local signal Lo (with the frequency of fLo) is applied to the local signal processing unit 2L. The signal that is applied to the RF signal processing unit 2R (with the frequency f1) and the signal that is applied the local signal processing unit 2L (with a frequency fLo) are mixed, and outputted through the second terminal 2b as a signal b2 with a frequency of f2 (= f1 - fLo) from the IF signal processing unit 2I. Note that when the signal a1 with the frequency f1 is inputted from the first terminal 2a, to some degree it is reflected without the frequency conversion being performed by the DUT 2, and is thus outputted as the signal b1, as is, with the frequency f1 from the first terminal 2a.

[0027]

When the signal a2 with the frequency f2 is inputted from the second terminal 2b, it is applied to the IF signal processing unit 2I. A local signal Lo (with the frequency fLo) is also applied to the local signal processing unit 2L. The signal that is applied to the RF signal processing unit 2R (with the frequency f1) and the signal that is applied to the local signal processing unit 2L (with a frequency fLo) are mixed, and are outputted through the first terminal 2a as a signal b1 with a frequency f1 (= f2+ fLo) from the RF signal processing unit 2R. Note that when the signal a2 with the frequency f2 is inputted from the second terminal 2b, to some degree it is reflected from the DUT 2 without frequency conversion being performed, and is outputted as the signal b2, as is, with the frequency f2 from the second terminal 2b.

[0028]

Here the signal a1 of the frequency f1 will be notated as a1(f1), the signal a2 of the frequency f2 will be notated as a2(f2), the signal b1 of the frequency f1 will be notated as b1(f1), and the signal b2 of the frequency f2 will be notated as b2 (f2).

[0029]

Fig. 2 (b) illustrates the relationship between the signals that are inputted and outputted at the first terminal 2a and the second terminal 2b. That is the equations:

b1 = M11 x a1 + M12 x a2, and

b2 = M21 x a1 + M22 x a2

are satisfied.

[0030]

Note that M11 and M22 are termed the first coefficients, and M12 and M21 are termed the second coefficients.

[0031]

Returning to Fig. 1, the network analyzer 1 is provided with ports 4a and 4b; a DUT local signal port 4c; a power supply 10; measuring units 20 and 30; a DUT local signal generator 40; switches 52, 54, and 56; a forward path error factor acquiring unit 60, a reverse path error factor acquiring unit 70; a measuring system error factor recording unit 80; an error factor acquiring unit 90; and a circuit parameter measuring unit 98.

[0032]

The port 4a is connected to the measuring unit 20 and the first terminal 2a. The port 4a outputs, to the first terminal 2a, the input signal (with the frequency f1) from the signal source 10.

[0033]

The port 4b is connected to the measuring unit 30 and the second terminal 2b. The port 4b outputs, to the second terminal 2b, the input signal (with the frequency f2) from the signal source 10.

[0034]

The DUT local signal port 4c is connected to the DUT local signal generator 40. The DUT local signal port 4c applies to the DUT 2 the DUT local signal from the DUT local signal generator 40.

[0035]

The signal source 10 has a signal outputting unit 12, a bridge 13, a switch 14, an internal mixer 16, and a receiver (Rch) 18 (input signal measuring means).

[0036]

The signal outputting unit 12 outputs the input signal with a frequency f1 or f2.

[0037]

A bridge 13 provides, to the internal mixer 16 and the switch 14, and the signal that is outputted from the signal outputting unit 12. The signal provided by the bridge 13 refers to the signal that has not been subjected to the effect of the measuring system error factors from the network analyzer 1.

[0038]

The switch 14 it has terminals 14a, 14b, and 14c. The terminal 14a is connected to the bridge 13, and receives a signal from the bridge 13. The terminal 14b is connected to the measuring unit 20, and the terminal 14c is connected to the measuring unit 30. The terminal 14a is connected to the terminal 14b or the terminal 14c. When the terminal 14a and the terminal 14b are connected, then the input signal that is outputted from the signal

outputting unit 12 (where the frequency of the input signal at this time is defined as f1) is applied to the measuring unit 20. When the terminal 14a and the terminal 14c are connected, the input signal that is the output from the signal outputting unit 12 (where the frequency of the input signal at this time is defined as f2) is applied to the measuring unit 30.

[0039]

The internal mixer 16 mixes the signal applied from the bridge 13 with the internal local signal and outputs the result.

[0040]

The receiver of (Rch) 18 (the input signal measuring means) measures the S parameter of the signal outputted by the internal mixer 16. Consequently, the receiver (Rch) 18 measures the S parameter pertaining to the input signal prior to the production of the effect of the measuring system error factors caused by the network analyzer 1.

[0041]

The measuring unit 20 has a bridge 23, an internal mixer 26, and a receiver (Ach) 28 (device-under-test signal measuring means).

[0042]

The bridge 23 outputs to the port 4a the signal applied from the signal source 10. Moreover, the signal that is returned by being reflected from the DUT 2 and the signal through the DUT 2 are received through the port 4a and provided to the internal mixer 26. The signal returned by being reflected by the DUT 2 and the signal through the DUT 2 are termed the device-under-test signals.

[0043]

The internal mixer 26 mixes and outputs the signal applied from the bridge 23 and the internal local signal.

[0044]

The receiver (Ach) 28 (the device-under-test signal measuring means) measures the S parameter of the signal outputted by the internal mixer 26. Consequently, the receiver (Ach) 28 measures the S parameter relating to the device-under-test signal.

[0045]

The measuring unit 30 has a bridge 33, an internal mixer 36, and a receiver (Bch) 38 (device-under-test signal measuring means).

[0046]

The bridge 33 outputs to the port 4ba the signal applied from the signal source 10. Moreover, the signal that is returned by being reflected from the DUT 2 and the signal through the DUT 2 are received through the port 4b and provided to the internal mixer 36. The signal returned by being reflected by the DUT 2 and the signal through the DUT 2 are termed the device-under-test signals.

[0047]

The internal mixer 36 mixes and outputs the signal applied from the bridge 33 and the internal local signal.

[0048]

The receiver (Bch) 38 (the device-under-test signal measuring means) measures the S parameter of the signal outputted by the internal mixer 36. Consequently, the receiver (Bch) 38 measures the S parameter relating to the device-under-test signal.

[0049]

The DUT local signal generator 40 applies a local signal Lo (with the frequency fLo) to the DUT 2.
[0050]
Note that Fig. 3 illustrates the state shown in Fig. 1, expressed using a signal flow graph. M11, M21, M12, and M22 are the true M parameters (that is, excluding the effects of the measuring system error factors) of the DUT 2.
[0051]
Fig. 3 (a) illustrates the state wherein the input signal (with the frequency f1) is applied to the DUT 2 through the measuring unit 20 (known as the forward path) (wherein the terminal 14a and the terminal 14b are connected), and Fig. 3 (b) illustrates the state wherein the input signal (with the frequency f2) is applied to the DUT 2 through the measuring unit 30 (known as the reverse path) (wherein the terminal 14a and the terminal 14c are connected).
[0052]
The measuring system error factors in the forward path (referencing Fig. 3 (a)) include Ed1 (the error arising from the bridge directionality), Ei1 and Eo1 (the error arising from the frequency tracking), Es1 (the error arising from the source matching), Eg2, and EL2.
[0053]
The measuring system error factors in the reverse path (referencing Fig. 3 (b)) include Ed2 (the error arising from the bridge directionality), Ei2 and Eo2 (the error arising from the frequency tracking), Es2 (the error arising from the source matching), Eg1, and EL1.
[0054]
The switch 52 applies the measuring result of the receiver (Ach) 28 to the forward path error factor acquiring unit 60, the error factor acquiring unit 90, or the circuit parameter measuring unit 98.
[0055]
The switch 54 applies the measuring result of the receiver (Bch) 38 to the reverse path error factor acquiring unit 70, the error factor acquiring unit 90, or the circuit parameter measuring unit 98.
[0056]
The switch 56 applies the measuring result of the receiver (Rch) 18 to the forward path error factor acquiring unit 60,the reverse path error factor acquiring unit 70, the error factor acquiring unit 90, or the circuit parameter measuring unit 98.
[0057]
The forward path error factor acquiring unit 60 receives the measurement result of the receiver (Ach) 28 through the switch 52. Moreover, the forward path error acquiring unit 60 receives the measurement result of the receiver (Rch) 18 through the switch 56. Additionally, Ed1, Ei1 · Eo1 (= Er1), Es1, and EL2 in the forward path (referencing Fig. 3 (a)) are acquired based on the measuring results of the receiver (Ach) 28 and the measuring results of the receiver (Rch) 18.
[0058]
Fig. 4 is a functional block diagram illustrating the structure of the forward path error factor acquiring unit 60. The forward path error factor acquiring unit 60 has a switch 62, a first forward path error factor acquiring unit 64, and a second forward path error factor acquiring unit 66.
[0059]

The switch 62 sends the measuring result of the receiver (Ach) 28 and the measuring result of the receiver (Rch) 18 to the first forward path error factor acquiring unit 64 or the second forward path error factor acquiring unit 66. Specifically, when the calibrating tool 6 (described below) is attached to the port 4a, the measuring result of the receiver (A CH) 28 and the measuring result of the receiver (Rch) 18 are sent to the first forward path error factor acquiring unit 64. When the port 4b is connected to the port 4a, then the measuring result of the receiver (Ach) and the measuring result of the receiver (Rch) 18 are sent to the second forward path error factor acquiring unit 66.

[0060]

The first forward path error factor acquiring unit 64 acquires Ed1, Ei1 · Eo1 (= Er1), and Es1. The state wherein the terminal 6a of the calibrating tool 6 and the port 4a are connected is illustrated in Fig. 5. The calibrating tool 6 is a known calibrating tool for achieving in the three states of Open, Shorted, and Loaded (with the standard load of Z0), as set forth in Japanese Unexamined Patent Application Publication H11-38054 (Patent Reference 1).

[0061]

Fig. 6 illustrates the state wherein the calibrating tool 6 is connected to the port 4a, expressed using a signal flow graph. Here the measuring result of the receiver (Rch) 18 is notated as R1(f1), and the measuring result of the receiver (Ach) 28 is notated as A1(f1). The relationship between R1(f1) and A1(f1) is as in the following equation:

[0062]

[Equation 1]

$$\frac{A1(f1)}{R1(f1)} = Ed1 + \frac{Er1 \cdot X}{1 - Es1 \cdot X}$$

Here the calibrating tool 6 has three different types of connections, so there are three different combinations of R1(f1) and A1(f1). Consequently, there are also three different variables that can be calculated: Ed1, Ei1 · Eo1 (= Er1), and Es1.

[0063]

The second forward path error factor acquiring unit 66 receives Ed1, Ei1 · Eo1 (= Er1), and Es1 from the first forward path error factor acquiring unit 64, and receives, through the switch 62, the measuring result of the receiver (Ach) 28 and of the receiver (Rch) 18. Doing this, the second forward path error factor acquiring unit 66 acquires EL2.

[0064]

Fig. 7 illustrates the state wherein the port 4b is connected to the port 4a. Fig. 8 illustrates the state wherein the port 4b is connected to the port 4a, expressed using a signal flow graph. Here the measuring result of the receiver (Rch) 18 is termed R1(f1), and the measuring result of the receiver (Ach) 28 is termed A1(f1). The input signal (with the frequency f1) is outputted from the port 4a through the measuring unit 20. The relationship between R1(f1) and A1(f1) is as in the following equation:

[0065]

[Equation 2]

$$\frac{A1(f1)}{R1(f1)} = Ed1 + \frac{Er1 \cdot EL2}{1 - Es1 \cdot EL2}$$

Here Ed1, Er1, and Es1 are already known, enabling the calculation of EL2. This second forward path error factor acquiring unit 66 outputs, to the measuring system error factor acquiring recording 80, Ed1, E11 · Eo1 (= Er1), Es1, and EL 2.
[0066]
The reverse path error factor acquiring unit 70 receives the measurement result of the receiver (Bch) 38 through the switch 54. Moreover, the reverse path error factor acquiring unit 70 receives the measurement result of the receiver (Rch) 18 through the switch 56. Additionally, Ed2, Ei2 · Eo2 (= Er2), Es2, and EL1 in the reverse path (referencing Fig. 3 (b)) are acquired based on the measuring results of the receiver (Bch) 38 and the measuring results of the receiver (Rch) 18.
[0067]
Fig. 9 is a functional block diagram illustrating the structure of the reverse path error factor acquiring unit 70. The reverse path error factor acquiring unit 70 has a switch 72, a first reverse path error factor acquiring unit 74, and a second reverse path error factor acquiring unit 76.
[0068]
The switch 72 sends the measuring result of the receiver (Bch) 38 and the measuring result of the receiver (Rch) 18 to the first reverse path error factor acquiring unit 74 or the second reverse path error factor acquiring unit 76. Specifically, when the calibrating tool 6 is attached to the port 4a, the measuring result of the receiver (Bch) 38 and the measuring result of the receiver (Rch) 18 are sent to the first reverse path error factor acquiring unit 74. When the port 4b is connected to the port 4a, then the measuring result of the receiver (Ach) and the measuring result of the receiver (Rch) 18 are sent to the second reverse path error factor acquiring unit 76.
[0069]
The first reverse path error factor acquiring unit 74 acquires Ed2, Ei2 · Eo2 (= Er2), and Es2. The calibrating tool 6 was explained above, and thus the explanation thereof will be omitted. Here, if the measuring result of the receiver (Rch) 18 is defined as R2(f2) and the measuring result of the receiver (Bch) 38 is defined as B2(f2), then the relationship between R2(f2) and B2 (f2) will be as in the following equation:
[0070]
[Equation 3]

$$\frac{B2(f2)}{R2(f2)} = Ed2 + \frac{Er2 \cdot X}{1 - Es2 \cdot X}$$

Here the calibrating tool 6 has three different types of connections, so there are three different combinations of R2(f1) and B2(f1). Consequently, there are also three different variables that can be calculated: Ed2, Ei2 · Eo2 (= Er2), and Es2.
[0071]
The second forward path error factor acquiring unit 76 receives Ed2, Ei2 · Eo2 (= Er2), and Es2 from the first reverse path error factor acquiring unit 74, and receives, through the switch 72, the measuring result of the receiver (Bch) 38 and of the receiver (Rch) 18. Doing this, the second forward path error factor acquiring unit 76 acquires EL1.
[0072]
Here the measuring result of the receiver (Rch) 18 is termed R1(f1), and the measuring result of the receiver (Bch) 38 is termed B2(f1). The relationship between R1(f1) and

A1(f1) is as in the following equation. The input signal (with the frequency f2) is outputted from the port 4b through the measuring unit 30.

[0073]

[Equation 4]

$$\frac{B2(f2)}{R2(f2)} = Ed2 + \frac{Er2 \cdot EL1}{1 - Es2 \cdot EL1}$$

Here Ed2, Er2, and Es2 are already known, enabling the calculation of EL1. This second reverse path error factor acquiring unit 76 outputs, to the measuring system error factor recording unit 80, Ed2, Ei2 · Eo2 (= Er2), Es2, and EL1.

[0074]

The measuring system error factor recording unit 80 receives Ed1, Ei1 · Eo1 (= Er1), Es1, and EL2 from the forward path error factor acquiring unit 60, receives Ed2, Ei2 · Eo2 (= Er2), Es2, and EL1 from the reverse path error factor acquiring unit 70, and records these error factors. Ed1, Er1, Es1, EL2, Ed2, Er2, Es2, and EL1 are measurement error factors that occur independently of the frequency conversion of the device under test.

[0075]

The error factor acquiring unit 90 acquires the transmission tracking that occurs due to the frequency conversion. Note that the transmission trackings Et21 and Et12 are respectively defined as Et21 = Ei1 · Eg2, and Et12 = Ei2 · Eg 1. The transmission tracking is a measuring system error factor that occurs due to the frequency conversion of the device under test.

[0076]

Additionally, when acquiring the transmission tracking, the calibration mixer 8 is connected to the network analyzer 1, as illustrated in Fig. 11. The calibration mixer 8 is essentially identical to the DUT 2. When the first coefficients are defined as M11' and M22', and the second coefficients are defined as M12' and M21', then the ratio of the |M12'| and |M21'| is constant, and if a bidirectional mixer is used as the calibration mixer 8, then |M12'| = |M21'|.

[0077]

Here the input signal (with the frequency f1) is applied to the calibration mixer 8 through the measuring unit 20, and the input signal (with the frequency f2) is applied to the calibration mixer 8 through the measuring unit 30, at which time the transmission tracking can be acquired from the measuring results of the receiver (Rch) 18, the measuring results of the receiver (Ach) 28, and the measuring results of the receiver (Bch) 38.

[0078]

Fig. 10 is a functional block diagram illustrating the structure of the error factor acquiring unit 90. The error factor acquiring unit 90 comprises a measuring system error factor reading out unit 910, a switch 922, a forward path measured data acquiring unit 924, a reverse path measured data acquiring unit 926, a circuit parameter acquiring unit (calibration coefficient outputting means) 928, and transmission tracking acquiring unit 930.

[0079]

The measuring system error factor reading out unit 910 reads out Ed1, Er1, Es1, EL2, Ed2, Er2, Es2, and EL1 from the measuring system error factor recording unit 80 and outputs to the transmission tracking acquiring unit 930.
[0080]
The switch 922 sends the measuring result of the receiver (Rch) 18, the measuring result of the receiver (Ach) 28, and the measuring result of the receiver (Bch) 38 to either the forward path measured data acquiring unit 924 or to the reverse path measured data acquiring unit 926. Specifically, when the input signal (with the frequency of f1) is applied through the measuring unit 20 (when the terminal 14a and the terminal 14b are connected), the measuring results are sent to the forward path measured data acquiring unit 924. When the input signal (with the frequency of f2) is applied through the measuring unit 30 (when the terminal 14a and the terminal 14c are connected), the measuring results are sent to the reverse path measured data acquiring unit 926.
[0081]
The forward path measured data acquiring unit 924 sends, to the circuit parameter acquiring unit 928, the measuring result of the receiver (Rch) 18, received from the switch 922, as R1(f1), the measuring results of the receiver (Ach) 28, received from the switch 922, as A1(f1), and the measuring results of the receiver (Bch) 38, received from the switch 922, as B1(f2).
[0082]
The reverse path measured data acquiring unit 926 sends, to the circuit parameter acquiring unit 928, the measuring result of the receiver (Rch) 18, received from the switch 922, as R1(f2), the measuring results of the receiver (Ach) 28, received from the switch 922, as A2(f1), and the measuring results of the receiver (Bch) 38, received from the switch 922, as B2(f2).
[0083]
The circuit parameter acquiring unit (the calibration coefficient outputting unit) 928 acquires the M parameter of the calibration mixer 8 based on R1(f1), A1(f1), and B1(f2) received from the forward path measured data acquiring unit 924, and on R2(f2), A2(f1), and B2(f2), received from the reverse path measured data acquiring unit 926.
[0084]
When the M parameters acquired by the circuit parameter acquiring unit 928 are defined as M11m', M12m', M21m', and M22m', then:

$M11m' = A1(f1)/R1(f1)$;

$M12m' = A2(f1)/R2(f2)$;

$M21m' = B1(f2)/R1(f1)$; and

$M22m' = B2(f2)/R2(f2)$.

[0085]
The transmission tracking acquiring unit 930 receives the M parameters M11m', M12m', M21m', and M22m' of the calibration mixer 8, acquired by the circuit parameter acquiring unit 928, and the Ed1, Er1, Es1, EL2, Ed2, Er2, Es2, and EL1, read out by the measuring system error factor reading out unit 910, to acquire the transmission trackings Et21 and Et12.
[0086]

First it can be seen, through analyzing the details of the network analyzer 1, that there will be relationships as shown in Formula 1, below. The proof will be given later. Note that the "L" in EL1 and EL2 is expressed as a lowercase "l".
[0087]
[Equation 5]

$$Eg_1 = \left(1 - Ed_1 \frac{Es_1 - El_1}{Er_1}\right) Eo_1$$

$$Eg_2 = \left(1 - Ed_2 \frac{Es_2 - El_2}{Er_2}\right) Eo_2$$

(Formula 1)

Consequently, when X is defined as Eo2/Eo1, then the transmission trackings Et21 and Et12 can be expressed as in formula 2, below. Note that the "L" in EL1 and EL2 is expressed as a lowercase "l".
[0088]
[Equation 6]

$$Et_{21} = Er_1 X \left(1 - Ed_2 \frac{Es_2 - El_2}{Er_2}\right)$$

$$Et_{12} = Er_2 \frac{1}{X} \left(1 - Ed_1 \frac{Es_1 - El_1}{Er_1}\right)$$

(Formula 2)

Note that Eo1 is an error factor that is produced prior to the reception by the receiver (Ach) 28 after the device-under-test signal is outputted from the DUT 2 first terminal 2a, and not the result of frequency conversion. Eo2 is an error factor that is produced prior to the reception by the receiver (Bch) 38 after the device-under-test signal is outputted from the DUT 2 second terminal 2b, and not the result of frequency conversion.
[0089]
Ed1, Er1, Es1, EL1, Ed2, Er2, Es2, and EL2 may be read out by the measuring system error factor reading out unit 910 for use. Consequently, if X is known, then it is possible to calculate the transmission trackings Et21 and Et12.
[0090]
Here the M parameters M11', M12', M21', and M22' of the calibration mixer 8, and the measured values M11m', M12m', M21m', and M22m' for the M parameters of the calibration mixer 8 that were acquired by the circuit parameter acquiring unit 928 have relationships as given in Formula 3, below. Note that the apostrophes used in, for example, M11' are omitted, so the notation is, for example, M11. Additionally, the L in EL1 and EL2 is notated as a lowercase l.
[0091]
[Equation 7]

$$\begin{pmatrix} M_{11} & M_{12} \\ M_{21} & M_{22} \end{pmatrix} = \begin{pmatrix} \frac{M_{11m} - Ed_1}{Er_1} & \frac{M_{12m}}{Et_{12}} \\ \frac{M_{21m}}{Et_{21}} & \frac{M_{22m} - Ed_2}{Er_2} \end{pmatrix} \begin{pmatrix} 1 + Es_1 \frac{M_{11m} - Ed_1}{Er_1} & El_1 \frac{M_{12m}}{Et_{12}} \\ El_2 \frac{M_{21m}}{Et_{21}} & 1 + Es_2 \frac{M_{22m} - Ed_2}{Er_2} \end{pmatrix}^{-1}$$

(Formula 3)

When M21'/M12' are calculated through the application of Formula 2 and Formula 3, the result is as in Formula 4, below. Note that the apostrophes used in, for example, M11' are omitted, so the notation is, for example, M11. Additionally, the L in EL1 and EL2 is notated as a lowercase l.

[0092]

[Equation 8]

$$\frac{M_{21}}{M_{12}} = \frac{1}{X^2} \cdot \frac{M_{21m}\left(1 - Ed_1 \frac{Es_1 - El_1}{Er_1}\right)\left[Er_2 + (M_{22m} - Ed_2)(Es_2 - El_2)\right]}{M_{12m}\left(1 - Ed_2 \frac{Es_2 - El_2}{Er_2}\right)\left[Er_1 + (M_{11m} - Ed_1)(Es_1 - El_1)\right]}$$

(Formula 4)

Here |M12'| = |M21'|, so M12' = M21' x e^{θ}, where θ is a constant determined by the phase of the local signal Lo. Solving Formula 4 for the X produces Formula 5, below. Note that the apostrophes used in, for example, M11' are omitted, so the notation is, for example, M11. Additionally, the L in EL1 and EL2 is notated as a lowercase l.

[0093]

[Equation 9]

$$X = e^{\frac{\theta}{2}} \sqrt{\frac{M_{21m}\left(1 - Ed_1 \frac{Es_1 - El_1}{Er_1}\right)\left[Er_2 + (M_{22m} - Ed_2)(Es_2 - El_2)\right]}{M_{12m}\left(1 - Ed_2 \frac{Es_2 - El_2}{Er_2}\right)\left[Er_1 + (M_{11m} - Ed_1)(Es_1 - El_1)\right]}}$$

(Formula 5)

Note that having the θ be 0 at a reference time mark, using any given point in time during the measuring system error factor acquisition from the forward path error factor acquiring unit 60 or the reverse path error factor acquiring unit 70 as the reference, enables the determination of the θ in Formula 5.

[0094]

Consequently, the transmission trackings Et21 and Et12 can be acquired based on X (Formula 2) by calculating X (Formula 5) based on Ed1, Er1, Es1, EL1, Ed2, Er2, Es2, and EL2 that are recorded in the measuring system error factor recording unit 80, and the M parameters M11m', M12m', M21m', and M22m' of the calibration mixer 8, acquired by the circuit parameter acquiring unit (calibration coefficient outputting means) 928.

[0095]

The circuit parameter measuring unit 98 acquires the true M parameters of the DUT 2. Note that "true M parameters" refers to those wherein the effect of the error factors has been eliminated.

[0096]

Additionally, when acquiring the true M parameters of the DUT 2, the DUT 2 is connected to the network analyzer 1 as illustrated in Fig. 1. The input signal (with the

frequency f1) is applied through the measuring unit 20 to the DUT 2, and the input signal (with the frequency f2) is applied to the measuring unit 30 to the DUT 2, and the true M parameters of the DUT 2 are acquired through the measuring results of the receiver (Rch) 18, the measuring results of the receiver (Ach) 28, and the measuring results of the receiver (Bch) 38 at that time.

[0097]

Fig. 12 is a functional block diagram illustrating the structure of the circuit parameter measuring unit 98. The circuit parameter measuring unit 98 comprises a measuring system error factor reading out unit 980, a switch 982, a forward path measured data acquiring unit 984, a reverse path measured data acquiring unit 986, and a circuit parameter acquiring unit 988.

[0098]

The measuring system error factor reading out unit 980 reads out Ed1, Er1, Es1, EL2, Ed2, Er2, Es2, and EL1 from the measuring system error factor recording unit 80 and outputs to the true value circuit parameter acquiring unit 989.

[0099]

The switch 982 sends the measuring result of the receiver (Rch) 18, the measuring result of the receiver (Ach) 28, and the measuring result of the receiver (Bch) 38 to either the forward path measured data acquiring unit 984 or to the reverse path measured data acquiring unit 986. Specifically, when the input signal (with the frequency of f1) is applied through the measuring unit 20 (when the terminal 14a and the terminal 14b are connected), the measuring results are sent to the forward path measured data acquiring unit 924. When the input signal (with the frequency of f2) is applied through the measuring unit 30 (when the terminal 14a and the terminal 14c are connected), the measuring results are sent to the reverse path measured data acquiring unit 986.

[0100]

The forward path measured data acquiring unit 984 sends, to the circuit parameter acquiring unit 988, the measuring result of the receiver (Rch) 18, received from the switch 982, as R1(f1), the measuring results of the receiver (Ach) 28, received from the switch 982, as A1(f1), and the measuring results of the receiver (Bch) 38, received from the switch 982, as B1(f2).

[0101]

The reverse path measured data acquiring unit 986 sends, to the circuit parameter acquiring unit 988, the measuring result of the receiver (Rch) 18, received from the switch 982, as R1(f2), the measuring results of the receiver (Ach) 28, received from the switch 982, as A2(f1), and the measuring results of the receiver (Bch) 38, received from the switch 982, as B2(f2).

[0102]

The circuit parameter acquiring unit 988 acquires the M parameters of the DUT 2 based on R1(f1), A1(f1), and B1(f2) received from the forward path measured data acquiring unit 984, and on R2(f2), A2(f1), and B2(f2), received from the reverse path measured data acquiring unit 986.

[0103]

When the M parameters acquired by the circuit parameter acquiring unit 988 are defined as M11m, M12m, M21m, and M22m, then:

M11m = A1(f1)/R1(f1);

M12m = A2(f1)/R2(f2);
M21m = B1(f2)/R1(f1); and
M22m = B2(f2)/R2(f2).

[0104]

The true value circuit parameter acquiring unit 989 acquires the true M parameters M11, M12, M21, and M22 of the DUT 2 by receiving the M parameters M11m, M12m, M21m, and M22m of the DUT 2 that were acquired by the circuit parameter acquiring unit 988, Ed1, Er1, Es1, EL2, Ed2, Er2, Es2, and EL1 that have been read out by the measuring system error factor reading out unit 980, and the transmission trackings Et21 and Et12 that have been acquired by the error factor acquiring unit 90.

[0105]

The true M parameters M11, M12, M21, and M22 of the DUT 2 can be calculated using Formula 3.

[0106]

The operation of the form of embodiment of the present invention will be explained next. Fig. 13 is a flowchart illustrating the operation of the form of embodiment of the present invention.

[0107]

First the measuring system error factors (Ed, Er, Es, EL, and Et) of the network analyzer 1 are acquired (S10). Note that Ed is the notation for Ed1 and Ed2, together; Er is the notation for Er1 and Er2, together; Es is the notation for Es1 and Es2, together; EL is the notation for EL1 and EL2, together; and Et is the notation for Et21 and Et12, together.

[0108]

Next the DUT 2 is connected to the network analyzer 1, and the M parameters of the DUT 2 are measured (S20).

[0109]

Fig. 14 is a flowchart illustrating the procedure for acquiring the measuring system error factors (Ed, Er, Es, EL, and Et) of the network analyzer 1.

[0110]

First the calibrating tool 6 is used to measure Ed, Er, and Es (S102).

[0111]

In detail, the first three types of calibrating tool 6 (Open, Shortage, and Load (with a standard load of Z0)) are connected to the port 4a. At this time, the measuring result for the receiver (Ach) 28 and the measuring result for the receiver (Rch) 18 are applied to the first forward path error factor acquiring unit 64 through the switch 62. The first forward path error factor acquiring unit 64 calculates Ed1, Er1, and Es1.

[0112]

Next the first three types of calibrating tool 6 (Open, Shortage, and Load (with a standard load of Z0)) are connected to the port 4b. At this time, the measuring result for the receiver (Bch) 38 and the measuring result for the receiver (Rch) 18 are applied to the first reverse path error factor acquiring unit 74 through the switch 72. The first reverse path error factor acquiring unit 74 calculates Ed2, Er2, and Es2.

[0113]

Next port 4a and port 4b are connected directly to measure EL (S104).

[0114]

More specifically, the input signal (frequency f1) is outputted from port 4a through the measuring unit 20. At this time, the measuring result of the receiver (Ach) 28 and the measuring result of the receiver (Rch) 18 are applied through the switch 62 to the second forward path error factor acquiring unit 66. The second forward path error factor acquiring unit 66 calculates EL2. The second forward path error factor acquiring unit 66 outputs Ed1, Er1, Es1, and EL2 to the measuring system error factor recording unit 80.

[0115]

Additionally, the input signal (frequency f2) is outputted from port 4b through the measuring unit 30. At this time, the measuring result of the receiver (Bch) 38 and the measuring result of the receiver (Rch) 18 are applied through the switch 72 to the second reverse path error factor acquiring unit 76. The second reverse path error factor acquiring unit 76 calculates EL1. The reverse forward path error factor acquiring unit 76 outputs Ed2, Er2, Es2, and EL1 to the measuring system error factor recording unit 80.

[0116]

Following this, the calibration mixer 8 is connected to the network analyzer 12 measure R, A, and B (S106). Note that R is the notation for R1(f1) and R2(f2), together; A is the notation for A1(f1) and A2(f1) together; and B is the notation for B1(f2) and B2(f2), together.

[0117]

Specifically, the input signal (with the frequency f1) is applied through the measuring unit 20. The measuring result of the receiver (Rch) 18, the measuring result of the receiver (Ach) 28, and the measuring result of the receiver (Bch) 38 are applied to the forward path measured data acquiring unit 924 through the switch 922. The forward path measured data acquiring unit 924 outputs R1(f1), A1(f1), and B1(f2) to the circuit parameter acquiring unit 928.

[0118]

Following this, the input signal (with the frequency f2) is applied through the measuring unit 30. The measuring result of the receiver (Rch) 18, the measuring result of the receiver (Ach) 28, and the measuring result of the receiver (Bch) 38 are applied to the reverse path measured data acquiring unit 926 through the switch 922. The reverse path measured data acquiring unit 926 outputs R2(f2), A2(f1), and B2(f2) to the circuit parameter acquiring unit 928.

[0119]

The circuit parameter acquiring unit 928 calculates the M parameters M11m', M12m', M21m', and M22m' of the calibration mixer 8.

[0120]

Finally, the transmission tracking acquiring unit 930 acquires the transmission trackings Et21 and Et12 after receiving the M parameters M11m', M12m', M21m', and M22m' for the calibration mixer 8 that have been obtained by the circuit parameter acquiring unit 928, and Ed1, Er1, Es1, EL2, Ed2, Er2, Es2, and EL1 read out from the measuring system error factor reading out unit 910 (S108).

[0121]

Specifically, X is calculated based on Formula 5, and substituted into Formula 2, enabling the acquisition of the transmission trackings Et21 and Et12.

[0122]

Fig. 15 is a flowchart illustrating the procedure for acquiring the M parameters of the DUT 2.
[0123]
First R, A, and B are measured by connecting the DUT 2 to the network analyzer 1 (S202).
[0124]
Specifically, the input signal (with the frequency f1) is applied through the measuring unit 20. The measuring result of the receiver (Rch) 18, the measuring result of the receiver (Ach) 28, and the measuring result of the receiver (Bch) 38 are applied to the forward path measured data acquiring unit 984 through the switch 982. The forward path measured data acquiring unit 984 outputs R1(f1), A1(f1), and B1(f2) to the circuit parameter acquiring unit 988.
[0125]
Following this, the input signal (with the frequency f2) is applied through the measuring unit 30. The measuring result of the receiver (Rch) 18, the measuring result of the receiver (Ach) 28, and the measuring result of the receiver (Bch) 38 are applied to the reverse path measured data acquiring unit 986 through the switch 982. The reverse path measured data acquiring unit 986 outputs R2(f2), A2(f1), and B2(f2) to the circuit parameter acquiring unit 988.
[0126]
The circuit parameter acquiring unit 988 calculates the M parameters M11m, M12m, M21m, and M22m of the DUT 2 (S204).
[0127]
Finally, the true value circuit parameter acquiring unit 989 acquires the transmission trackings Et21 and Et12 after receiving the M parameters M11m, M12m, M21m, and M22m for DUT 2 that have been obtained by the circuit parameter acquiring unit 988, and Ed1, Er1, Es1, EL2, Ed2, Er2, Es2, and EL1 read out from the measuring system error factor reading out unit 980, to obtain the true M parameters M11, M12, M21, and M22 of the DUT 2 (S206).
[0128]
In the form of embodiment according the present invention, in order to calculate the transmission tracking Et21 and Et12, a process for enabling the acquisition of the phase is performed by (1) connecting the port 4a to the calibrating tool 6 and the connecting the port 4b to the calibrating tool 6, (2) directly connecting the port 4a to the port 4b, and (3) connecting the calibration mixer 8 to the port 4a and the port 4b, thus enabling the acquisition of the transmission tracking phase, thereby enabling the correction of the error in the measuring system.
[0129]
Note that while in the present form of embodiment according to the present invention, the explanation was one wherein there were two ports (port 4a and port 4b) for outputting the input signal to the network analyzer 1 and for receiving the device-under-test signal from the DUT 2, instead there may be three or more of these types of ports.
[0130]
For example, as illustrated in Fig. 6, there may also be a port 4d and a port 4e, in addition to the ports 4a and 4b. The modified example (1) illustrated in Fig. 16, has the addition of ports 4d and 4e, terminals 14d and 14e is a for the switch 14, the bridges 123

and 133, internal mixers 126 and 136, a receiver (Dch) 128 (device-under-test signal measuring means), and a receiver (Cch) 138 (device under test measuring means), to the network analyzer 1. The other components are as explained above. Note that in Fig. 16, the DUT local signal generator 40, the switches 52, 54, 56, the forward path error factor acquiring unit 60, the reverse path error factor acquiring unit 70, the measuring system error factor recording unit 80, the error factor acquiring unit 90, and the circuit parameter measuring unit 98 are omitted from the figure for convenience in the figure.

[0131]

The terminals 14d and 14e of the switch 14 are connected to the bridges 133 and 123.

[0132]

The bridges 123 and 133 output the signal that is applied from the signal source 10 towards the ports 4e and 4d. Furthermore, the signal that has been reflected and returned from the device under test, and the signal that has traversed the device under test, are received by the ports 4e and 4d, and are provided to the internal mixers 126 and 136.

[0133]

The internal mixers 126 and 136 mix and output the signals obtained from the bridges 123 and 133 with the internal local signal.

[0134]

The receiver (Dch) 128 and the receiver (Cch) 138 measure the S parameters of the signal that has been outputted.

[0135]

For example, as illustrated in Fig. 17, there may be a port 4d and a port 4e in addition to the ports 4a and 4b. The modified example (2) illustrated in Fig. 17 eliminates, from the modified example (1), the bridge 13, the internal mixer 16, and the receiver (Rch) 18, and instead, has bridges 13b, 13c, 13d, and 132, internal mixers 16b, 16c, 16d, and 16e, and receivers (Rch) 18b, 18c, 18d, and 18d. Note that in Fig. 17, the DUT local signal generator 40, the switches 42, 54, and 56, the forward path error factor acquiring unit 60, the reverse path error factor acquiring unit 70, the measuring system error factor recording unit 80, the error factor acquiring unit 90, and the circuit parameter measuring unit 98 are omitted from the figure for convenience in the figure.

[0136]

The terminals 14d, 14c, 14d, and 14e of the switch 14 are connected to the bridges 13b, 13c, 13d, and 13e.

[0137]

The bridges 13b, 13c, 13d, and 13e output, towards the ports 4a, 4b, 4d, and 4e, the signal provided by the signal source, through the bridges 23, 33, 133, and 123. Furthermore, the signal that is reflected and returned from the device under test, along with the signal that traverses the device under test, are received through the ports 4a, 4b, 4d, and 4e, and are provided to the internal mixers 16b, 16c, 16d, and 16e.

[0138]

The internal mixers 16b, 16c, 16d, and 16e mix the signals that are applied from the bridges 13b, 13c, 13d, and 13e with the internal local signal, and output the results.

[0139]

The receivers (Rch) 18b, 18c, 18d, and 18e measure the S parameter of the signals outputted by the internal mixers 16b, 16c, 16d, and 16e.

[0140]

The modified example (2) illustrated in Fig. 17 has Es1 = EL1, Es2 = EL2, and so forth, and thus the measurements and calculations are easy.
[0141]
Additionally, it the form of embodiment set forth above can be achieved as described below. Media recorded with a program for embodying the various components set forth above (for example, the forward path error factor acquiring unit 60, the reverse path error factor acquiring unit 70, the measuring system error factor recording unit 80, and the error factor acquiring unit 90) are read out by a media reading device of a computer that is provided with a CPU, a hard disk, and a media (such as a floppy (registered trademark) disk, and a CD-ROM, or the like) reading device, and installed on the hard disk. The form of embodiment described above can be achieved through this method as well.

[Proof of Formula 1]
The path from SG1 to port 1 is divided into blocks A, B, and C, as illustrated in Fig. 18. When the switch is switched to the 1: FWD side (when outputting the signal) and the 2: REV side (when not outputting the signal), the status changes in only the C block.
[0142]
Here the A block reflection coefficient and transmission coefficient are defined as big 8x and big 8y, respectively. The b block S parameter is defined as Bij (where i and j = 1, 2, 3).
When the switch is at the 1: FWD side, the C block reflection coefficient and transmission coefficient are defined as Cx and Cy.
When the switch is at the 2: REV side, the C block reflection coefficient is defined as Cz.
With these definitions, the FWD system is illustrated by the signal flow graph as shown in Fig. 19, and the REV system is illustrated by the signal flow graph illustrated in Fig. 20.
[0143]
Focusing here on only the dependence relationship of the receiver detecting value and the port 1 signal, that is, focusing only on the dependence relationships of r1(f1), A1(f1), A2(f1), a1(f 1), b1(f1), a1"(f1), and b1"(f1), the signal flow graph illustrated in Fig. 19 can be modified to that in Fig. 21, and the signal flow graph illustrated in Fig. 20 can be modified to that of Fig. 22, in order to reduce the variables.
[0144]
P11, P21, P12, P22, Qx, and Qyare functions of, respectively, Bij (i, j = 1, 2, 3) and Ax and Ay, where the relationships are calculated hereafter based on the formula below, and so these relationships are not clear.
[0145]
The signal flow graph illustrated in Fig. 21 that corresponds to the error factors of the measuring system illustrated in Fig. 23, and the signal flow graph illustrated in Fig. 22 corresponds to these error factors of the measuring system illustrated in fig. 24.
[0146]
For this reason, the correspondence relationship in the equations is as follows.
[0147]
[Equation 10]

$FWD:$

$$Ed_1 = Cy\frac{1}{1-P_{11}Cx}Qx$$

$$Es_1 = P_{22} + P_{12}\frac{Cx}{1-P_{11}Cx}P_{21}$$

$$Ei_1 = Cy\frac{1}{1-P_{11}Cx}P_{21}$$

$$Eo_1 = Qy + P_{12}\frac{Cx}{1-P_{11}Cx}Qx$$

$REV:$

$$El_1 = P_{22} + P_{12}\frac{Cz}{1-P_{11}Cz}P_{21}$$

$$Eg_1 = Qy + P_{12}\frac{Cz}{1-P_{11}Cz}Qx$$

Consequently, the calculations are performed as follows:

[0148]

[Equation 11]

$$Ed_1\frac{Es_1 - El_1}{Ei_1} = \cdots = P_{12}Qx\frac{Cx - Cz}{(1-P_{11}Cx)(1-P_{11}Cz)}$$

$$Eo_1 - Eg_1 == \cdots = P_{12}Qx\frac{Cx - Cz}{(1-P_{11}Cx)(1-P_{11}Cz)}$$

$$\therefore Ed_1\frac{Es_1 - El_1}{Ei_1} = Eo_1 - Eg_1$$

$$\Leftrightarrow Eg_1 = Eo_1 - Ed_1\frac{Es_1 - El_1}{Ei_1} = \left(1 - Ed_1\frac{Es_1 - El_1}{Ei_1 Eo_1}\right)Eo_1 = \left(1 - Ed_1\frac{Es_1 - El_1}{Er_1}\right)Eo_1$$

$$\therefore Eg_1 = \left(1 - Ed_1\frac{Es_1 - El_1}{Er_1}\right)Eo_1$$

[End of Proof of Formula 1]

[Brief Description of the Drawings]

[0149]

Fig. 1 is a block diagram illustrating the structure of a network analyzer 1 according to a form of embodiment according to the present invention.

[0150]

Fig. 2 is a diagram illustrating the structure of a DUT 2 (Fig. 2 (a)), and a diagram illustrating the relationship between the signals that are inputted to/outputted from the first terminal 2a and the second terminal 2b (Fig. 2 (d)).

[0151]

Fig. 3 is a figure illustrating the state (known as the forward path) wherein the input signal (with the frequency f1) is applied to the DUT 2 through a measuring unit 20 (that is, the terminal 14a and the terminal 14b are connected to each other) (Fig. 3 (a)), and the state (known as the reverse path) wherein the input signal (with the frequency f2) is applied to the DUT 2 through a measuring unit 30 (that is, terminal 14a and terminal 14c are connected) (Fig. 3 (b).

[0152]

Fig. 4 is a functional block diagram illustrating the structure of the forward path error factor acquiring unit 60.
[0153]
Fig. 5 is a diagram illustrating the state wherein the terminal 6a of the calibrating tool 6 is connected to the port 4a.
[0154]
Fig. 6 is a signal flow graph expressing the state wherein the calibrating tool 6 is connected to the port 4a.
[0155]
Fig. 7 is a diagram illustrating the state wherein the port 4b is connected to the port 4a.
[0156]
Fig. 8 is a signal flow graph expressing the state wherein the port 4b is connected to the port 4a.
[0157]
Fig. 9 is a functional block diagram illustrating the structure of the reverse path error factor acquiring unit 70.
[0158]
Fig. 10 is a functional block diagram illustrating the structure of the error factor acquiring unit 90
[0159]
Fig. 11 is a diagram illustrating a calibration mixer 8 in the state that is connected to the network analyzer 1.
[0160]
Fig. 12 is a functional block diagram illustrating the structure of the circuit parameter measuring unit 98.
[0161]
Fig. 13 is a flowchart illustrating the operation of the form of embodiment according to the present invention.
[0162]
Fig. 14 is a flowchart illustrating the procedure for acquiring the measuring system error factors (Ed, Er, Es, EL, Et) of the network analyzer 1.
[0163]
Fig. 15 is a flowchart illustrating the procedure for acquiring the M parameters of the DUT 2.
[0164]
Fig. 16 is a block diagram illustrating the structure of a network analyzer 1 according to a modified example (1).
[0165]
Fig. 17 is a block diagram illustrating the structure of a network analyzer 1 according to a modified example (2).
[0166]
Fig. 18 is a block diagram illustrating the structure of the network analyzer 1, referenced for the proof of formula 1.
[0167]
Fig. 19 is a signal flow graph for achieving the FWD system in the network analyzer 1 illustrated in Fig. 18.

[0168]
Fig. 20 is a signal flow graph for achieving the REV system in the network analyzer 1 illustrated in Fig. 18.
[0169]
Fig. 21 has the signal flow graph modified as illustrated in Fig. 19
[0170]
Fig. 22 has the signal flow graph modified as illustrated in Fig. 20.
[0171]
Fig. 23 is a diagram illustrating the error factors in the measuring system corresponding to the signal flow graph illustrated in Fig. 21.
[0172]
Fig. 24 is a diagram illustrating the error factors in the measuring system corresponding to the signal flow graph illustrated in Fig. 22.
[0173]
Fig. 25 is a diagram for explaining the method of measuring the circuit parameters of the device under test (DUT) according to the prior art.
[0174]
Fig. 26 is a signal flow graph relating to the signal source 110 in the case wherein the frequencies f1 = f2 in the prior art.
[0175]
Fig. 27 is a signal flow graph relating to the signal source 110 in the case wherein the frequency f1 does not equal the frequency f2 in the prior art.
[0176]
Fig. 28 is a signal flow graph for the case wherein the signal source 110 and the receiving unit 120 are connected directly in the prior art.
[Explanation of Codes]
[0177]
1: Network Analyzer
4a, 4b: Ports
4c: DUT Local Signal Port
10: Signal Source
18: Receiver (Rch) (Input Signal Measuring Means)
28: Receiver (Ach) (Device-under-test signal Measuring Means)
38: Receiver (Bch) (Device-under-test signal Measuring Means)
20, 30: Measuring Units
40: DUT Local Signal Generator
52, 54, 56: Switches
60: Forward Path Error Factor Acquiring Unit
70: Reverse Path Error Factor Acquiring Unit
80: Measuring System Error Factor Recording Unit
90: Error Factor Acquiring Unit
910: Measuring System Error Factor Reading Out Unit
922: Switch
924: Forward Path Measured Data Acquiring Unit
926: Reverse Path Measured Data Acquiring Unit
928: Circuit Parameter Acquiring Unit (Calibration Coefficient Outputting Means)

930: Transmission Tracking Acquiring Unit
98: Circuit Parameter Measuring Unit
2: DUT
2a: First Terminal
2b: Second Terminal
2R: RF Signal Processing Unit
2I: IF Signal Processing Unit
2L: Local Signal Processing Unit

[Title of Document] Drawings

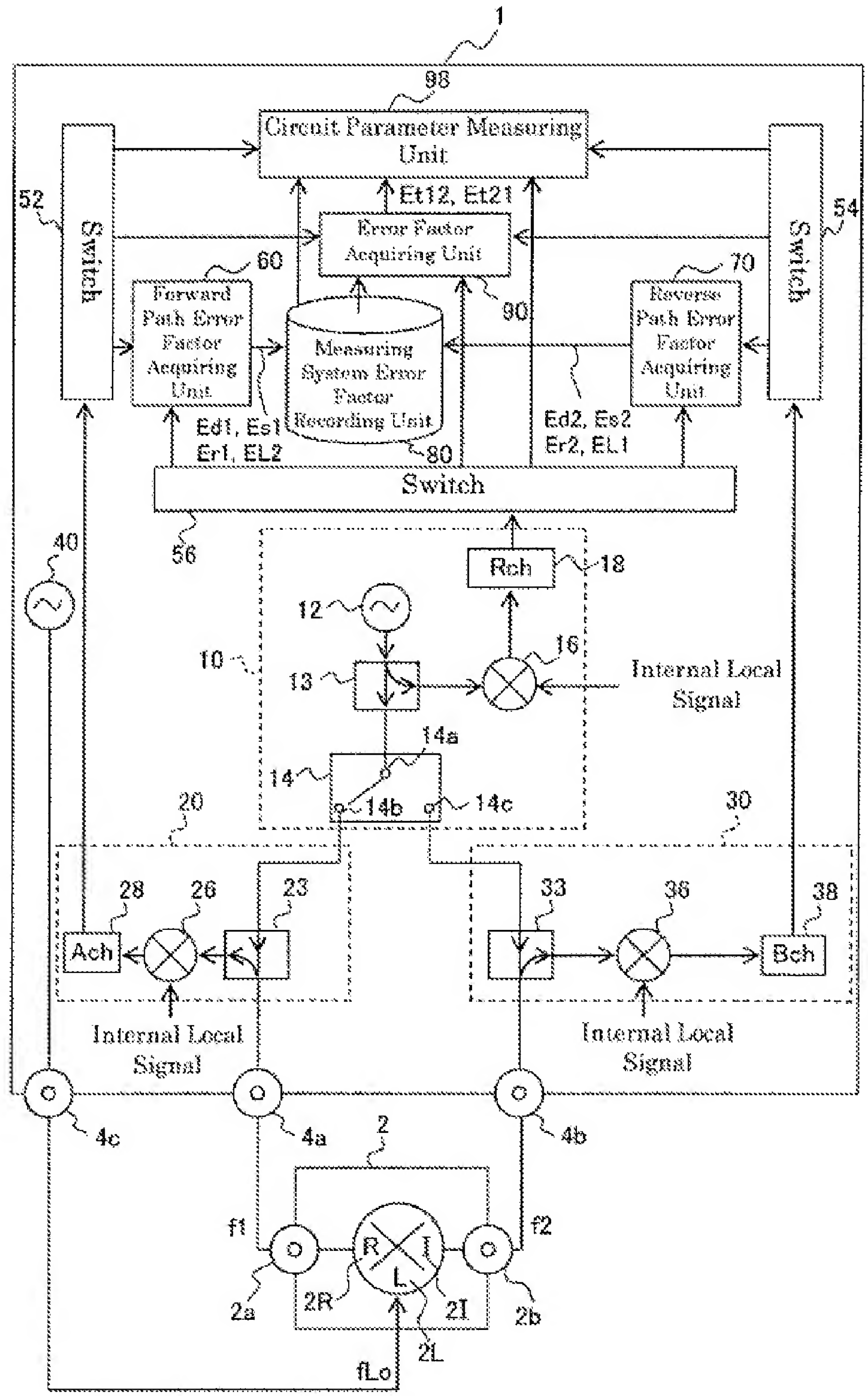
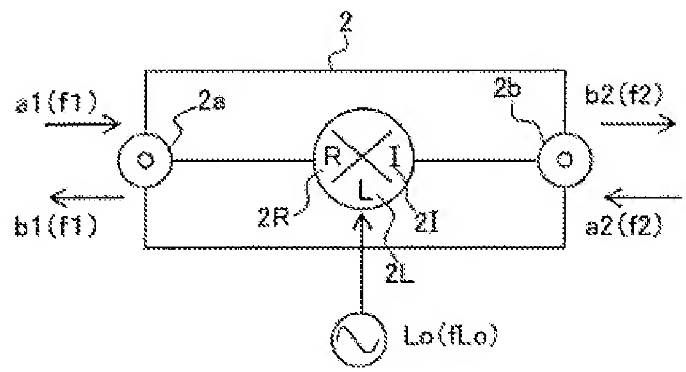

1
98
Circuit Parameter Measuring Unit
Et12, Et21
Error Factor Acquiring Unit
52
Switch
54
Switch
60
Forward Path Error Factor Acquiring Unit
70
Reverse Path Error Factor Acquiring Unit
90
Measuring System Error Factor Recording Unit
80
Ed1, Es1
Er1, EL2
Ed2, Es2
Er2, EL1
Switch
56
40
Rch
18
12
16
10
13
Internal Local Signal
14a
14
14b
14c
20
30
28
26
23
33
36
38
Ach
Bch
Internal Local Signal
Internal Local Signal
4c
4a
4b
2
f1
f2
R
I
L
2a
2R
2I
2b
2L
fLo

Fig. 1

(a)

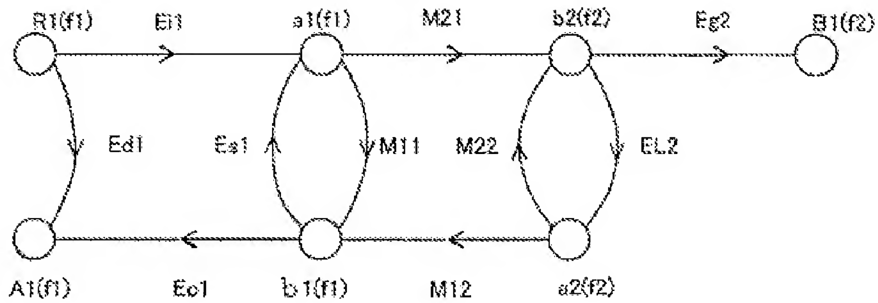


(b)

$$\begin{pmatrix} b1(f1) \\ b2(f2) \end{pmatrix} = \begin{pmatrix} M11 & M12 \\ M21 & M22 \end{pmatrix} \begin{pmatrix} a1(f1) \\ a2(f2) \end{pmatrix}$$

Fig. 2

(a)


R1(f1)
Ei1
a1(f1)
M21
b2(f2)
Eg2
B1(f2)
Ed1
Es1
M11
M22
EL2
A1(f1)
Eo1
b1(f1)
M12
a2(f2)

(b)

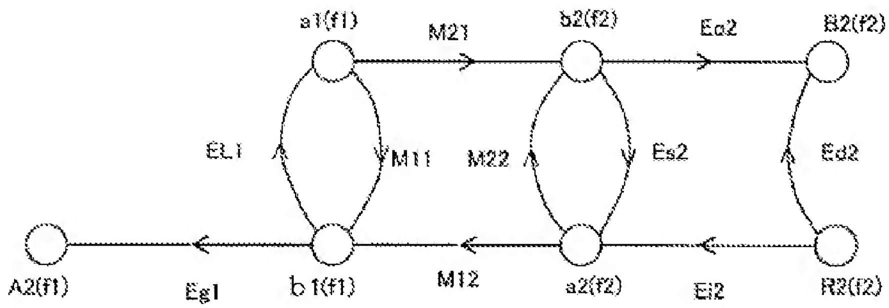

a1(f1)
M21
b2(f2)
Eo2
B2(f2)
EL1
M11
M22
Es2
Ed2
A2(f1)
Eg1
b1(f1)
M12
a2(f2)
Ei2
R2(f2)

Fig. 3

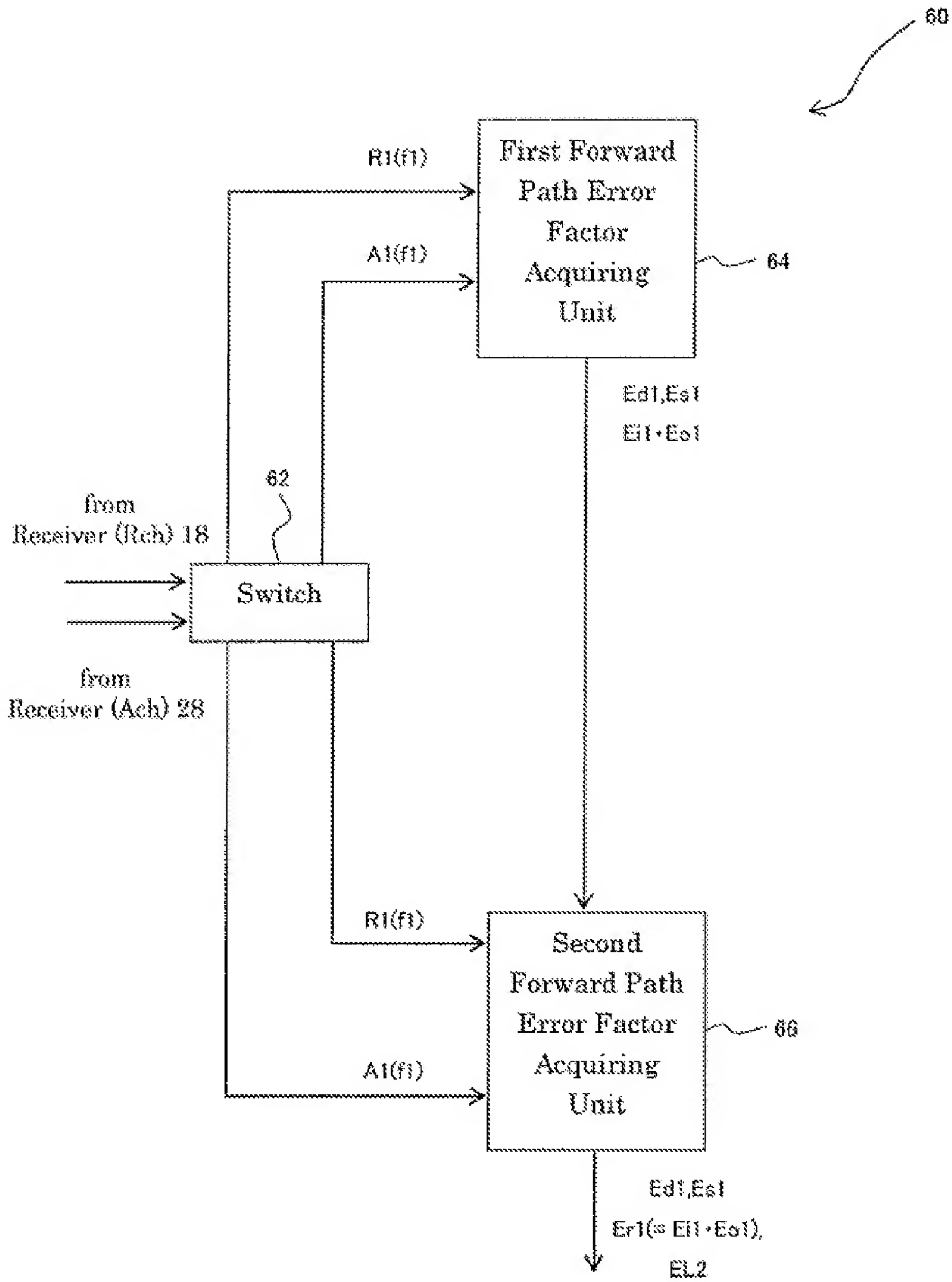

60
R1(f1)
First Forward Path Error Factor Acquiring Unit
A1(f1)
64
Ed1,Es1
Ei1·Eo1
62
from Receiver (Rch) 18
Switch
from Receiver (Ach) 28
R1(f1)
Second Forward Path Error Factor Acquiring Unit
66
A1(f1)
Ed1,Es1
Er1(= Ei1·Eo1),
EL2

Fig. 4

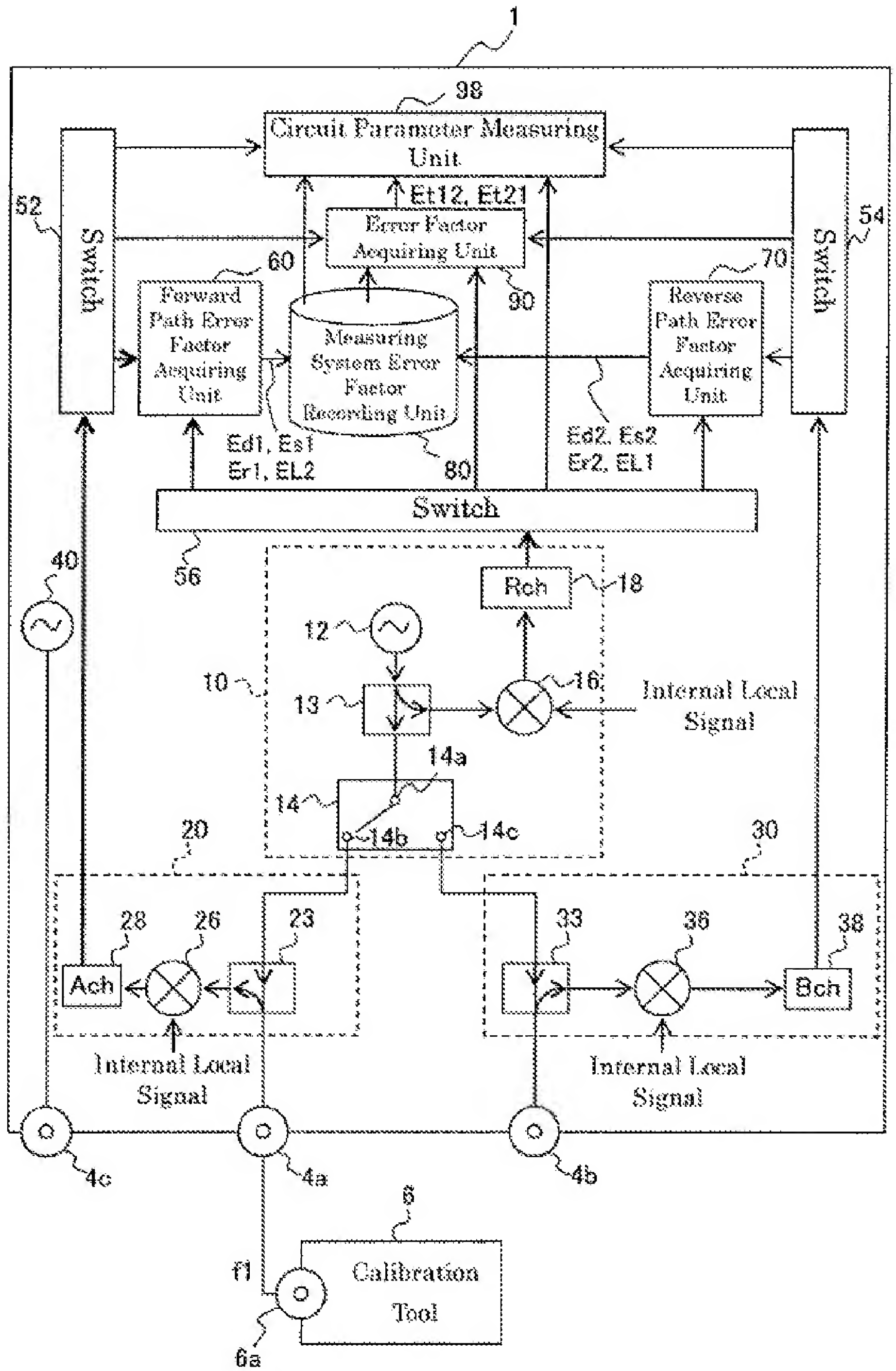

1
98
Circuit Parameter Measuring Unit
Et12, Et21
Error Factor Acquiring Unit
90
52
Switch
54
Switch
60
Forward Path Error Factor Acquiring Unit
Measuring System Error Factor Recording Unit
80
70
Reverse Path Error Factor Acquiring Unit
Ed1, Es1
Er1, EL2
Ed2, Es2
Er2, EL1
Switch
56
40
Rch
18
12
10
13
16
Internal Local Signal
14a
14
14b
14c
20
30
28
26
23
33
36
38
Ach
Bch
Internal Local Signal
Internal Local Signal
4c
4a
4b
6
Calibration Tool
f1
6a

Fig. 5

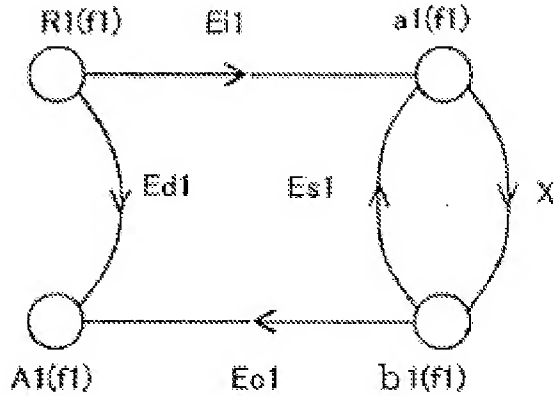


Fig. 6

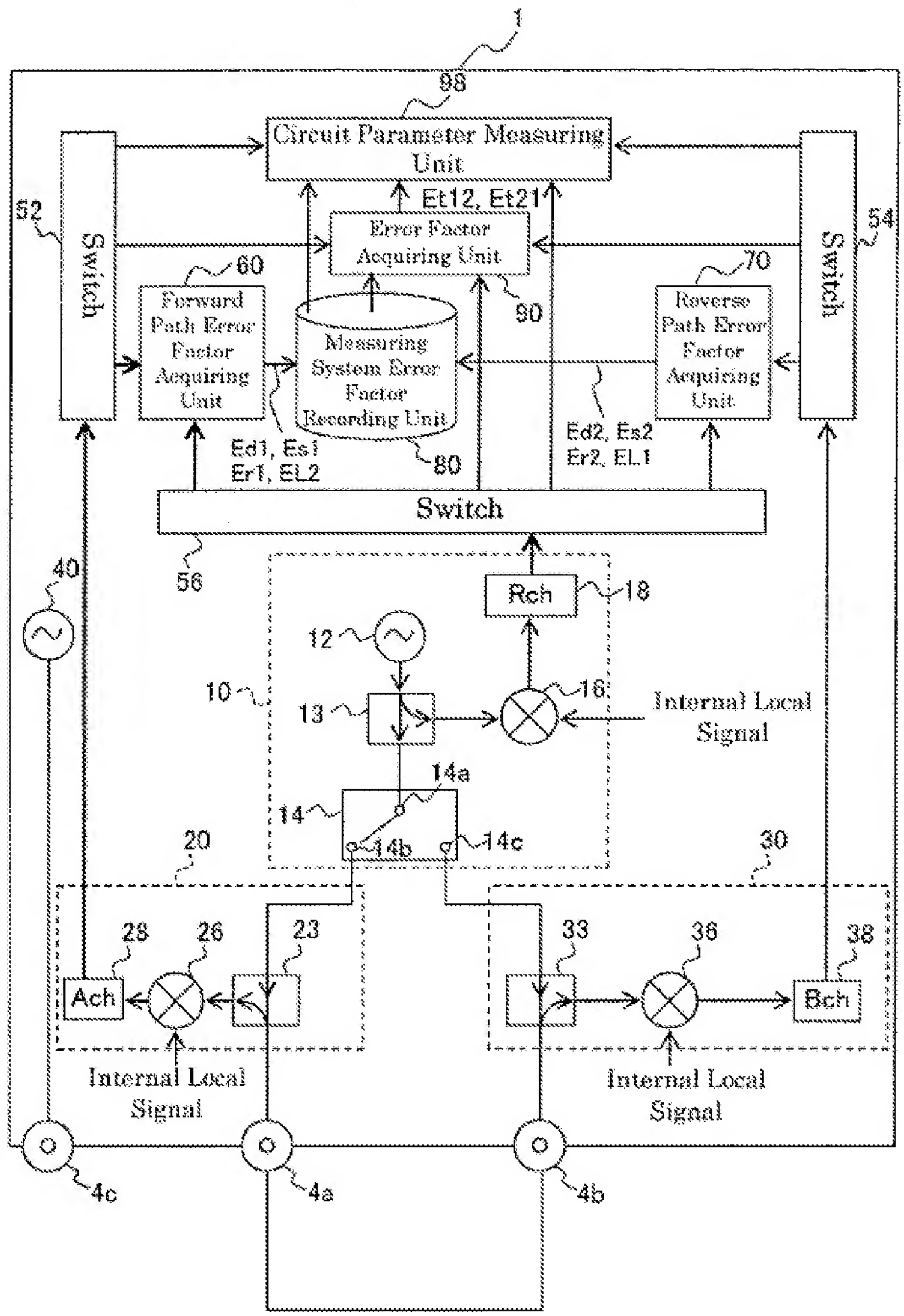

1
98
Circuit Parameter Measuring Unit
Et12, Et21
Error Factor Acquiring Unit
52
Switch
60
Forward Path Error Factor Acquiring Unit
Measuring System Error Factor Recording Unit
90
70
Reverse Path Error Factor Acquiring Unit
Switch
54
Ed1, Es1
Er1, EL2
80
Ed2, Es2
Er2, EL1
Switch
56
40
Rch
18
12
10
13
16
Internal Local Signal
14a
14
14b
14c
20
30
28
26
23
33
36
38
Ach
Bch
Internal Local Signal
Internal Local Signal
4c
4a
4b

Fig. 7

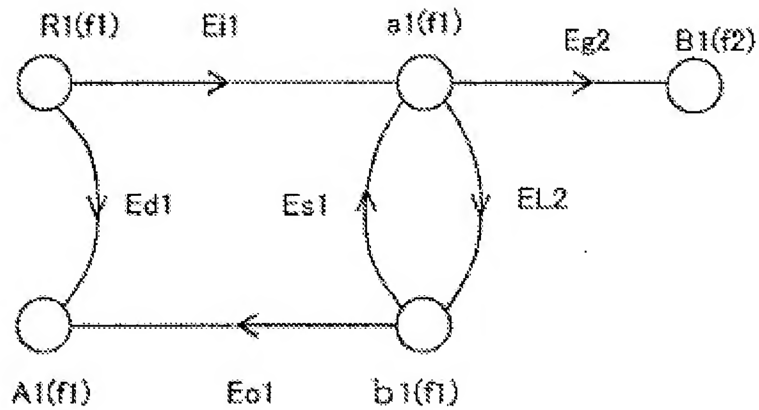


Fig. 8

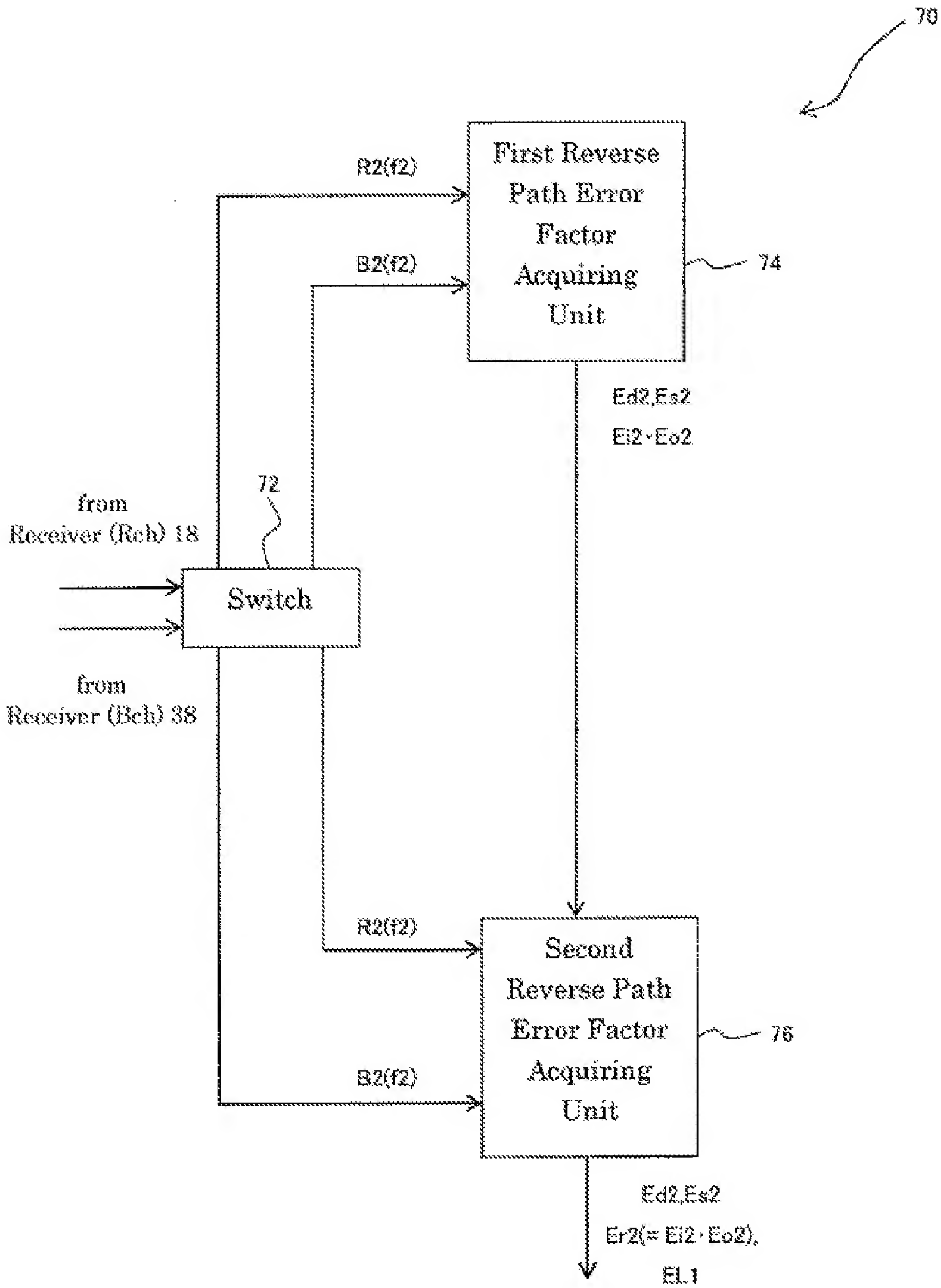
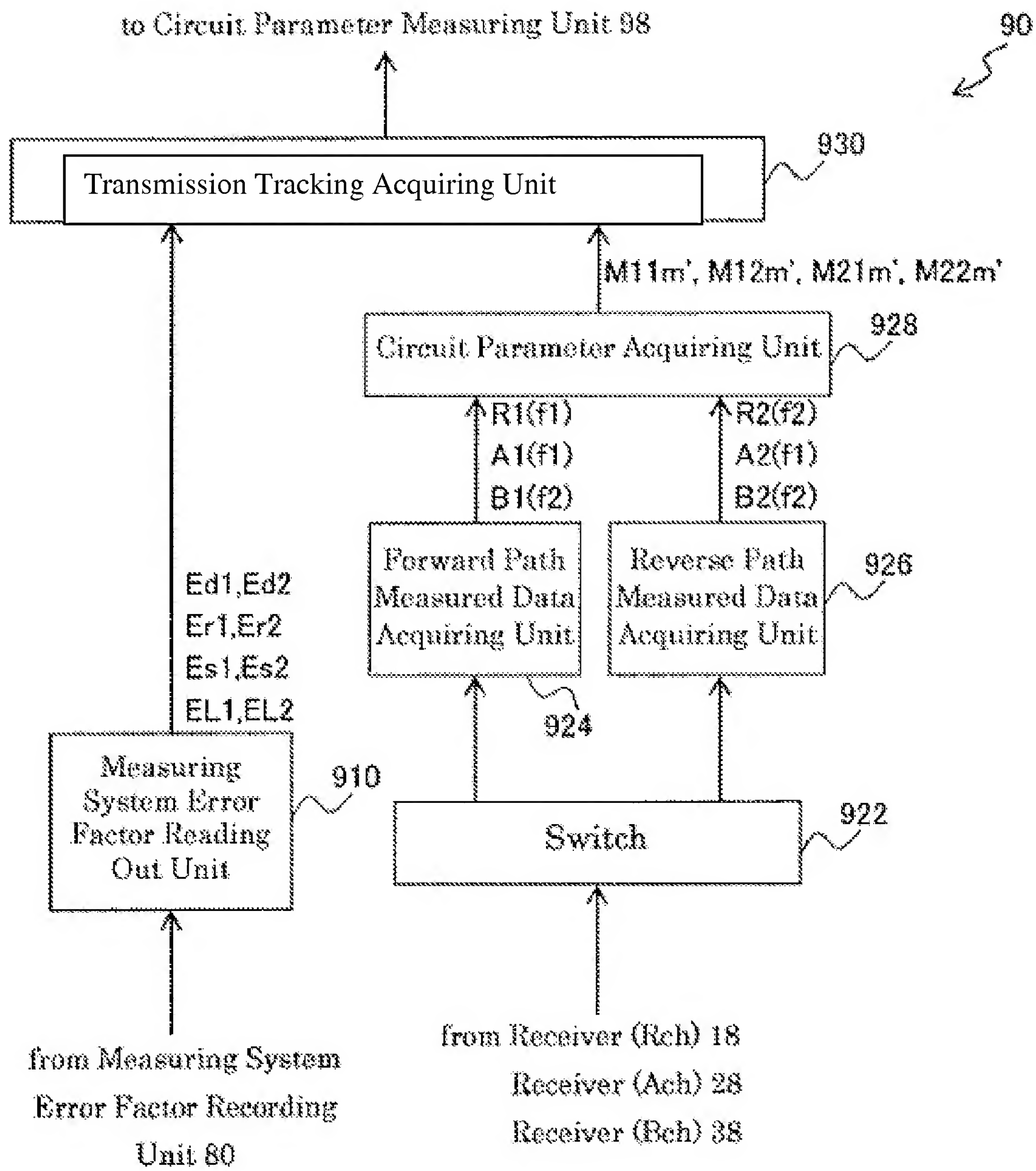

70
First Reverse Path Error Factor Acquiring Unit
74
R2(f2)
B2(f2)
Ed2,Es2
Ei2·Eo2
72
from Receiver (Rch) 18
Switch
from Receiver (Bch) 38
R2(f2)
B2(f2)
Second Reverse Path Error Factor Acquiring Unit
76
Ed2,Es2
Er2(= Ei2·Eo2),
EL1

Fig. 9



to Circuit Parameter Measuring Unit 98
90
Transmission Tracking Acquiring Unit
930
M11m', M12m', M21m', M22m'
Circuit Parameter Acquiring Unit
928
R1(f1)
A1(f1)
B1(f2)
R2(f2)
A2(f1)
B2(f2)
Forward Path Measured Data Acquiring Unit
Reverse Path Measured Data Acquiring Unit
926
924
Ed1,Ed2
Er1,Er2
Es1,Es2
EL1,EL2
Measuring System Error Factor Reading Out Unit
910
Switch
922
from Measuring System Error Factor Recording Unit 80
from Receiver (Rch) 18
Receiver (Ach) 28
Receiver (Bch) 38

Fig. 10

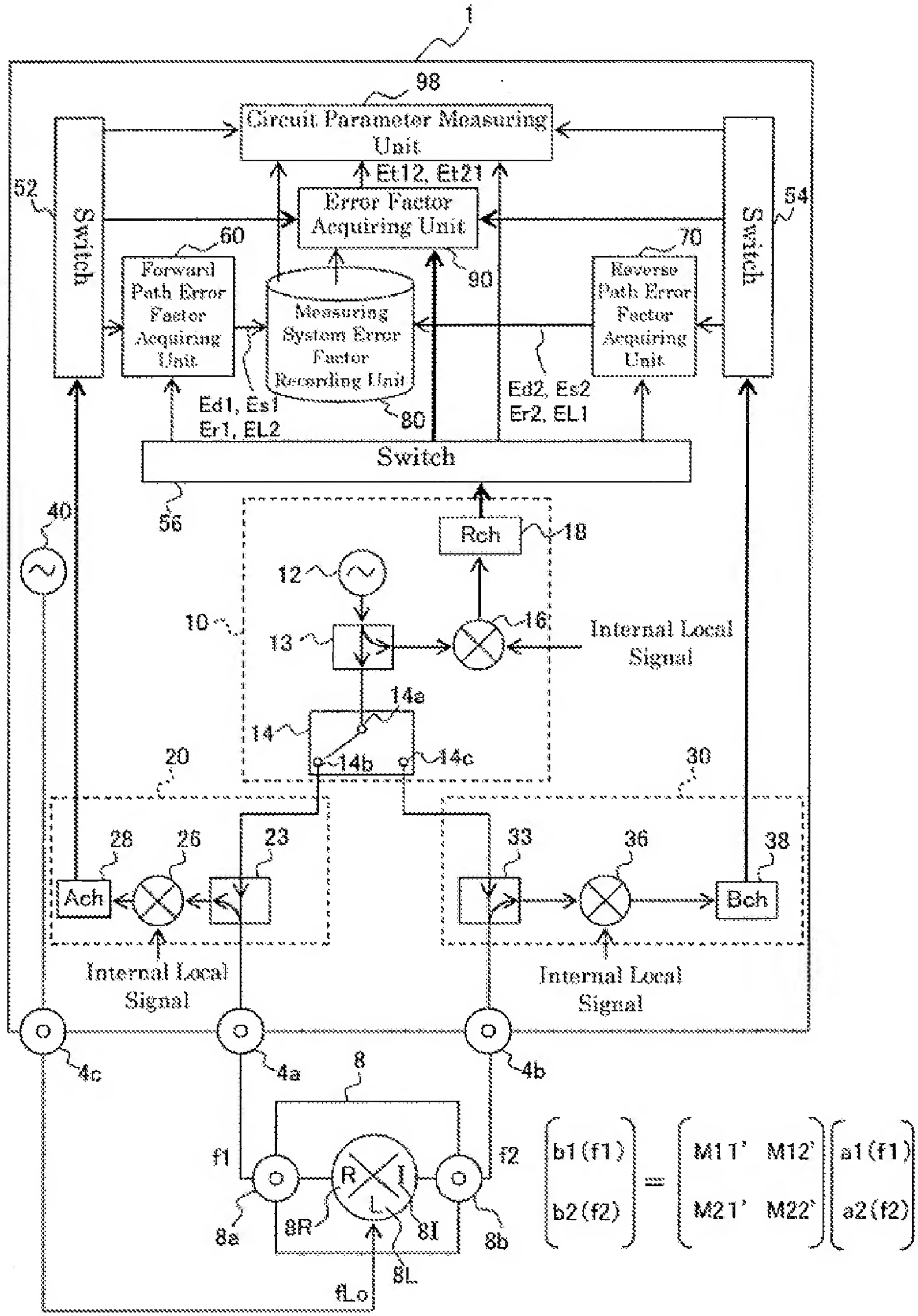

1
98
Circuit Parameter Measuring Unit
Et12, Et21
Error Factor Acquiring Unit
52
Switch
54
Switch
60
Forward Path Error Factor Acquiring Unit
70
Reverse Path Error Factor Acquiring Unit
90
Measuring System Error Factor Recording Unit
80
Ed1, Es1
Er1, EL2
Ed2, Es2
Er2, EL1
Switch
56
40
Rch
18
12
10
13
16
Internal Local Signal
14a
14
14b
14c
20
30
28
26
23
33
36
38
Ach
Bch
Internal Local Signal
Internal Local Signal
4c
4a
4b
8
f1
f2
R
I
L
8a
8R
8I
8b
8L
fLo
b1(f1)
b2(f2)
=
M11'
M12'
M21'
M22'
a1(f1)
a2(f2)

Fig. 11

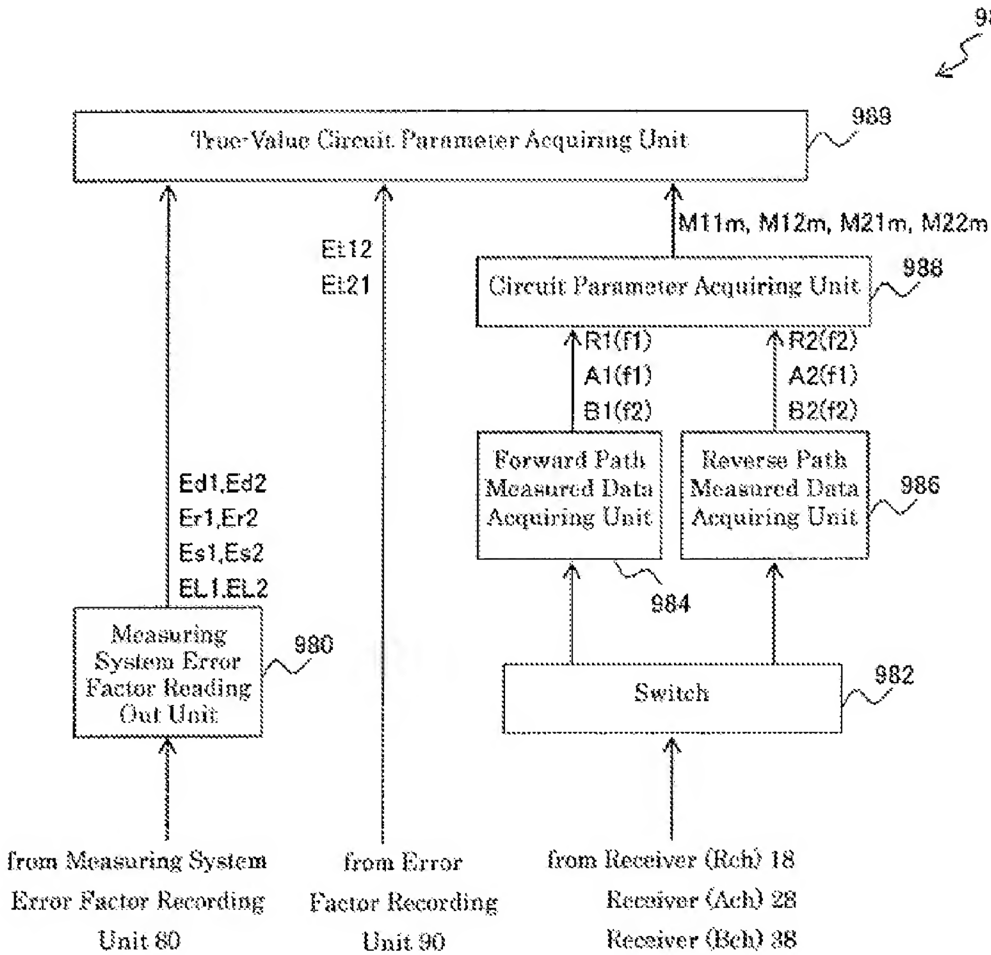

98
True-Value Circuit Parameter Acquiring Unit
989
M11m, M12m, M21m, M22m
Et12
Et21
Circuit Parameter Acquiring Unit
988
R1(f1)
A1(f1)
B1(f2)
R2(f2)
A2(f1)
B2(f2)
Forward Path Measured Data Acquiring Unit
Reverse Path Measured Data Acquiring Unit
986
984
Ed1,Ed2
Er1,Er2
Es1,Es2
EL1,EL2
Measuring System Error Factor Reading Out Unit
980
Switch
982
from Measuring System Error Factor Recording Unit 80
from Error Factor Recording Unit 90
from Receiver (Rch) 18
Receiver (Ach) 28
Receiver (Bch) 38

Fig. 12

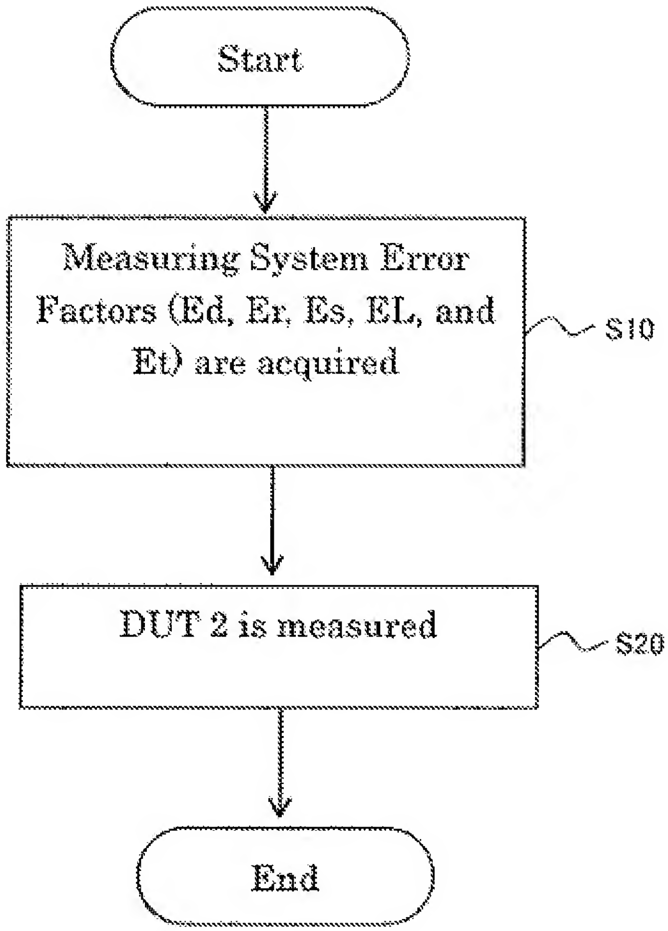

Start
Measuring System Error Factors (Ed, Er, Es, EL, and Et) are acquired
S10
DUT 2 is measured
S20
End

Fig. 13

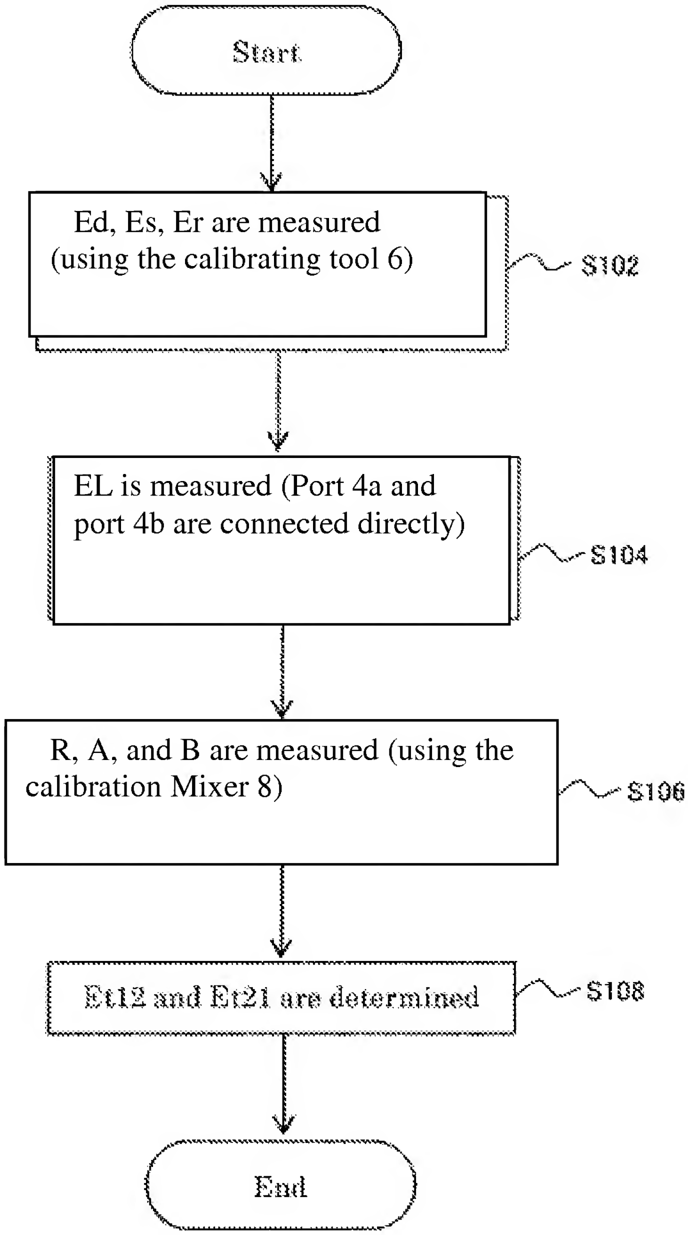
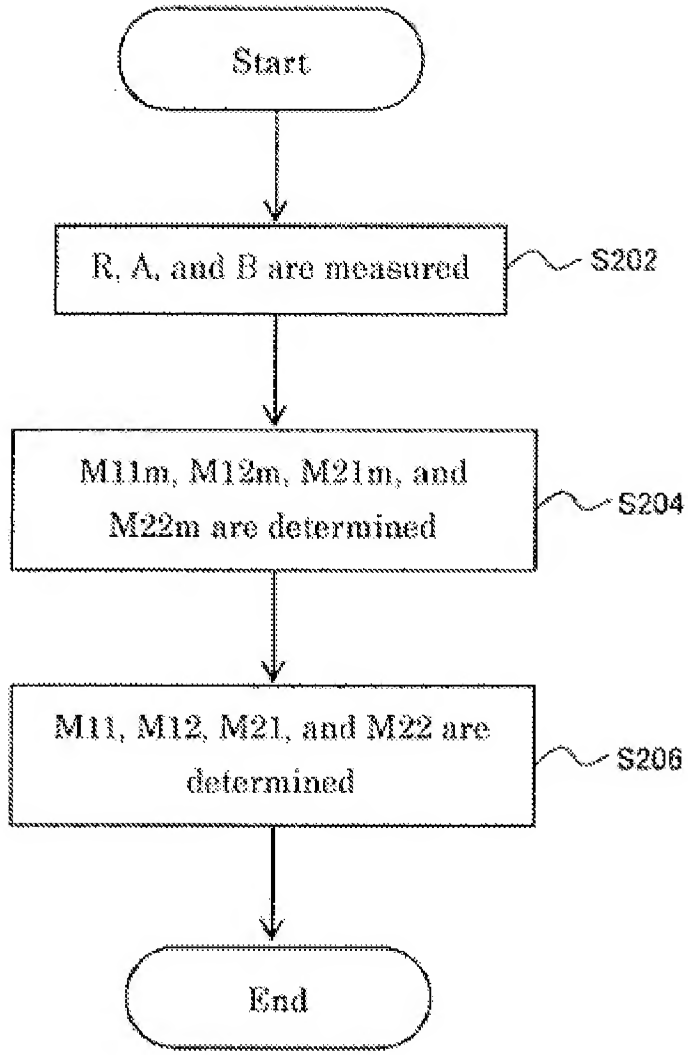

Start
Ed, Es, Er are measured (using the calibrating tool 6)
S102
EL is measured (Port 4a and port 4b are connected directly)
S104
R, A, and B are measured (using the calibration Mixer 8)
S106
Et12 and Et21 are determined
S108
End

Fig. 14



Start
R, A, and B are measured
S202
M11m, M12m, M21m, and
M22m are determined
S204
M11, M12, M21, and M22 are
determined
S206
End

Fig. 15

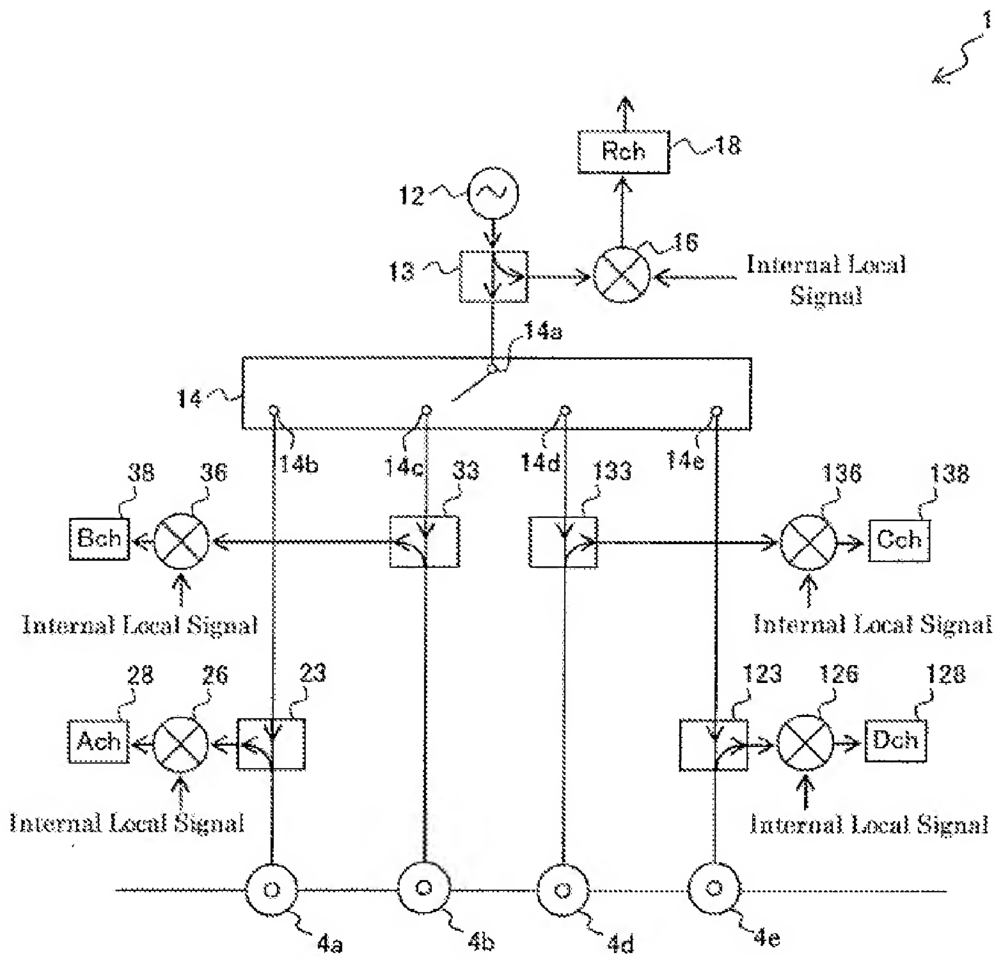

1
Rch
18
12
13
16
Internal Local Signal
14a
14
14b
14c
14d
14e
38
36
33
133
136
138
Bch
Cch
Internal Local Signal
Internal Local Signal
28
26
23
123
126
128
Ach
Dch
Internal Local Signal
Internal Local Signal
4a
4b
4d
4e

Fig. 16

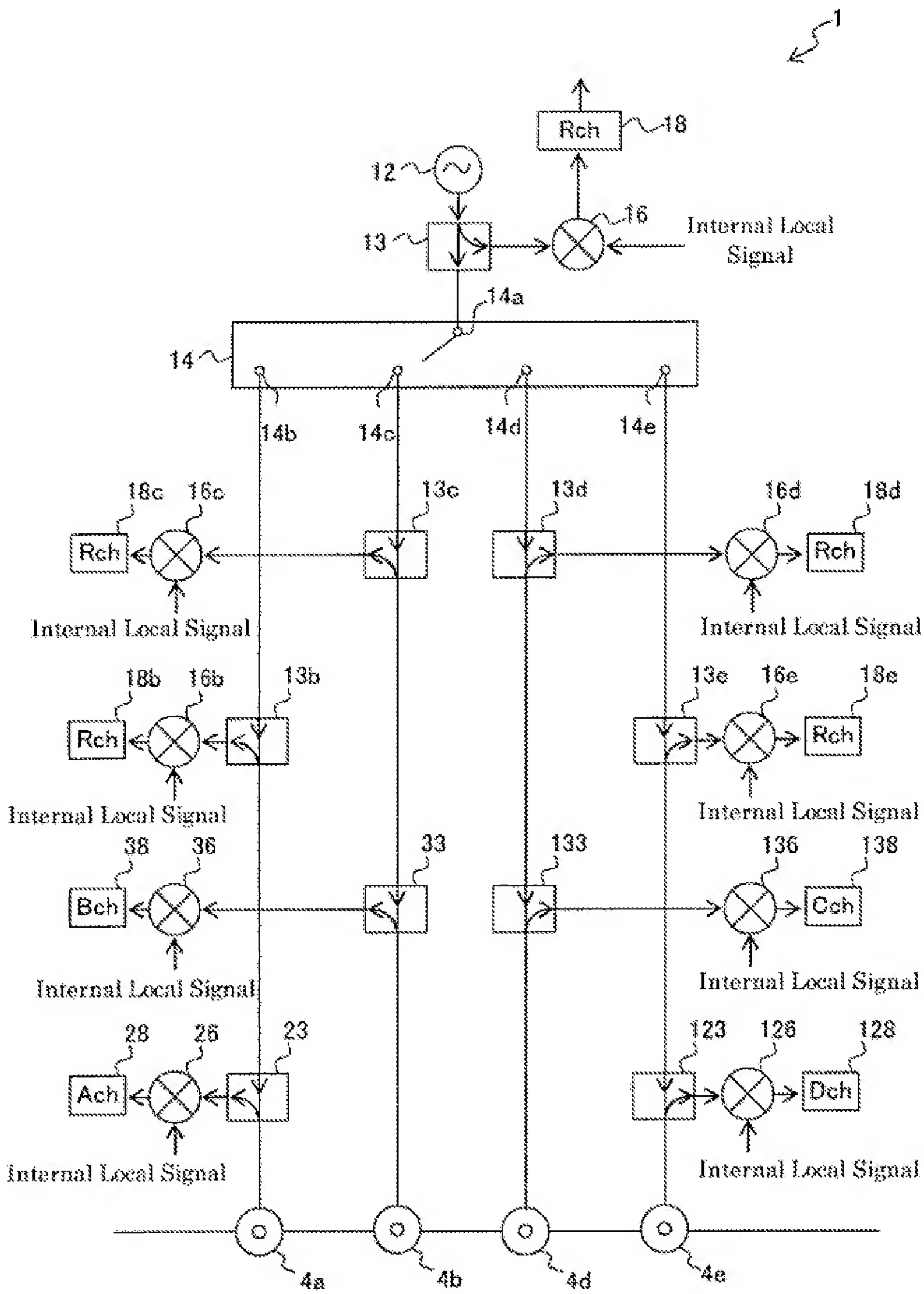

1
Rch
18
12
13
16
Internal Local Signal
14a
14
14b
14c
14d
14e
18c
16c
13c
13d
16d
18d
Rch
Rch
Internal Local Signal
Internal Local Signal
18b
16b
13b
13e
16e
18e
Rch
Rch
Internal Local Signal
Internal Local Signal
38
36
33
133
136
138
Bch
Cch
Internal Local Signal
Internal Local Signal
28
26
23
123
126
128
Ach
Dch
Internal Local Signal
Internal Local Signal
4a
4b
4d
4e

Fig. 17

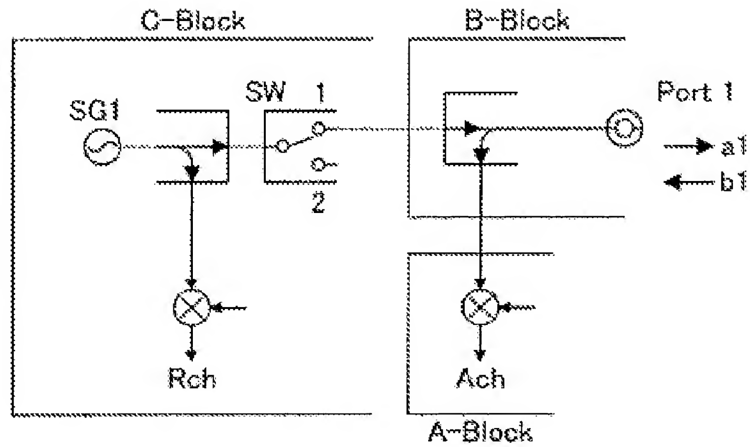
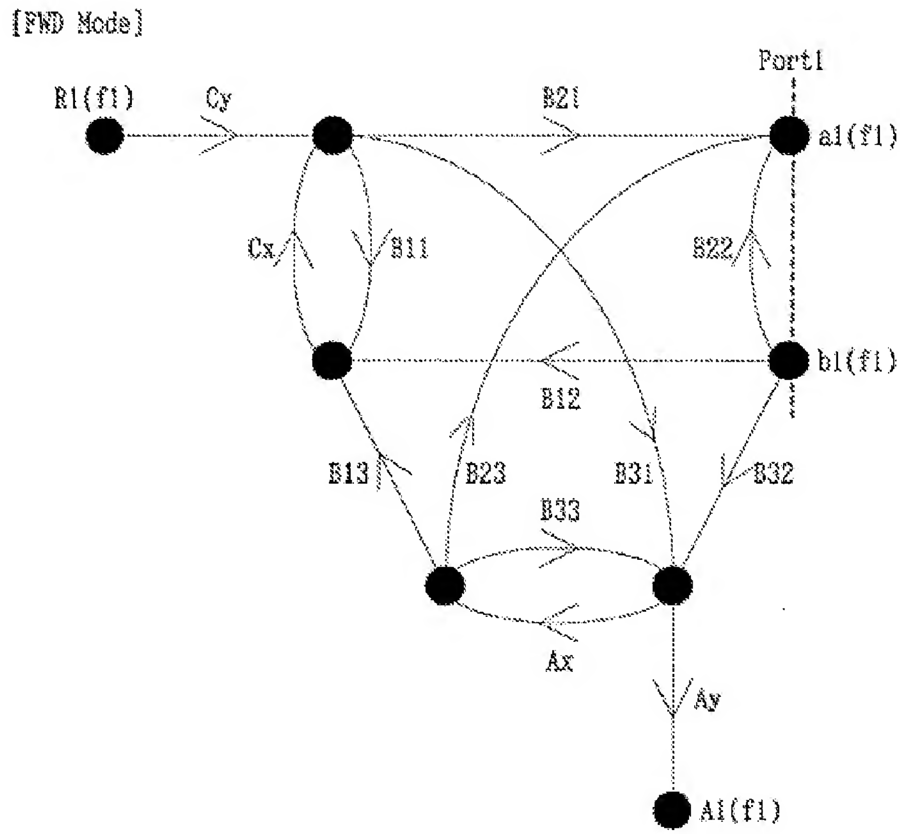


Fig. 18



[FWD Mode]
Port1
R1(f1)
Cy
B21
a1(f1)
Cx
B11
B22
b1(f1)
B12
B13
B23
B31
B32
B33
Ax
Ay
A1(f1)

Fig. 19

[REV Mode]

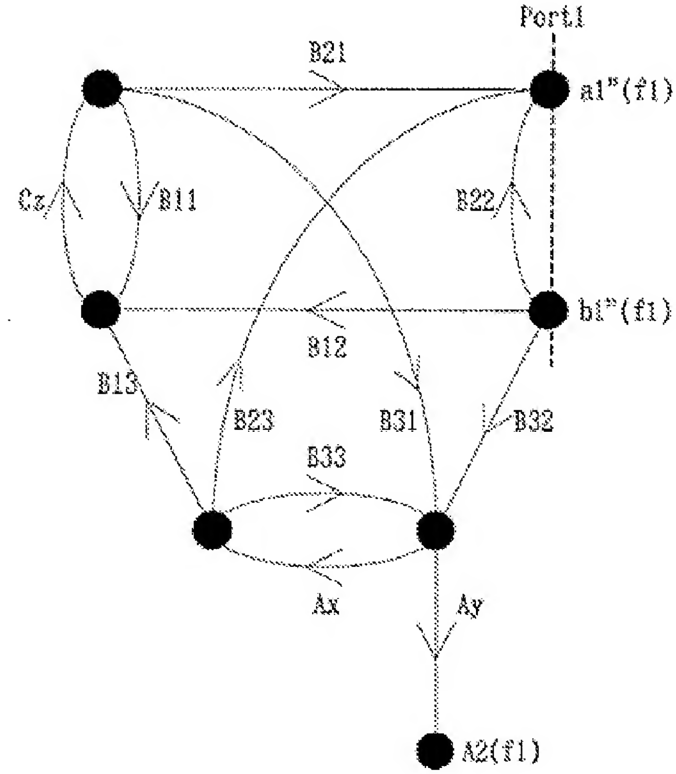


Fig. 20

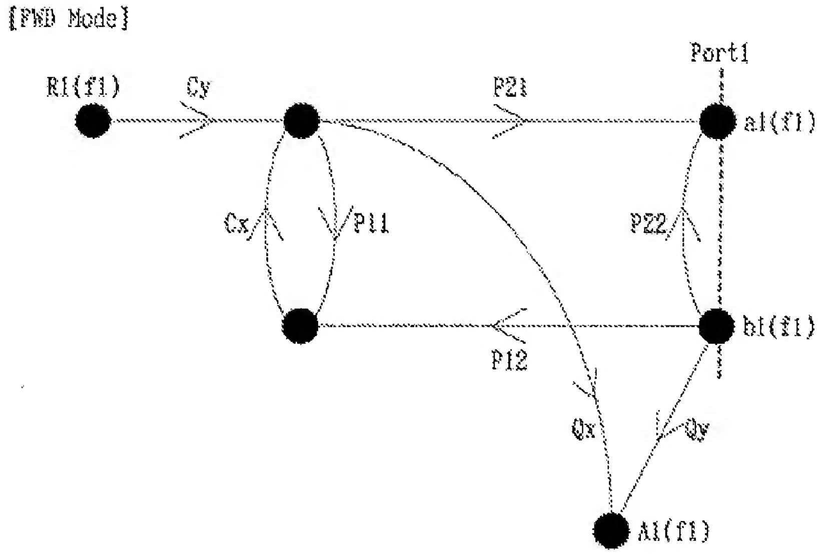


Fig. 21

[REV Mode]

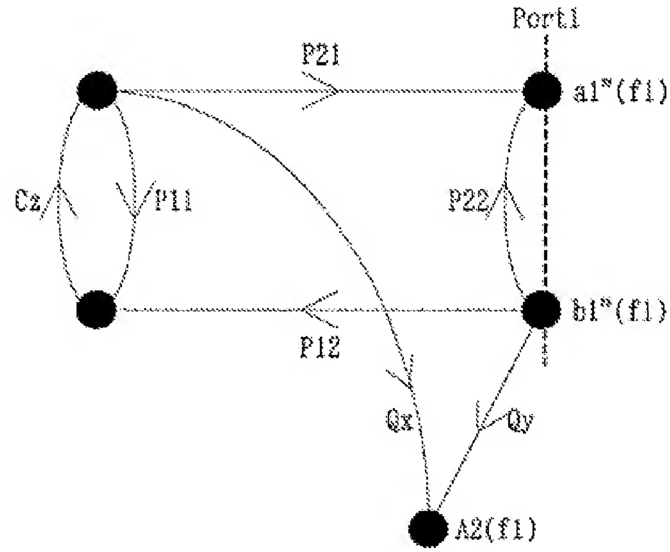


Fig. 22

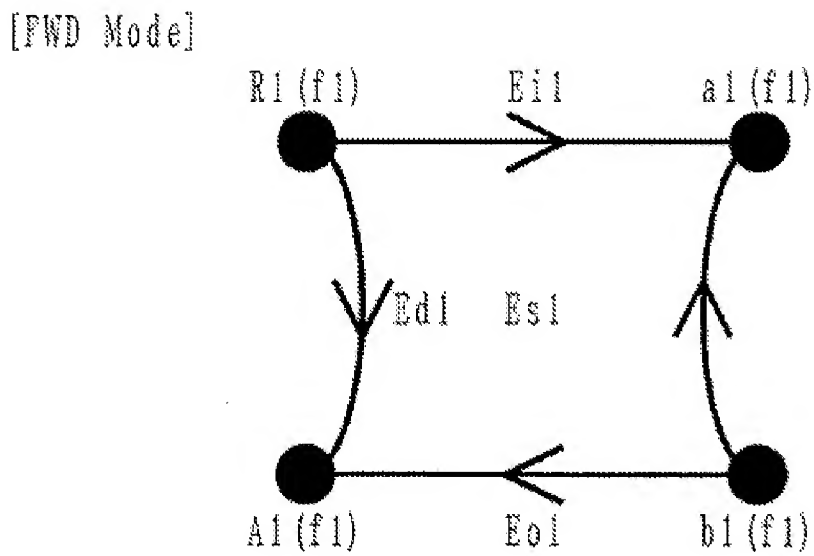


Fig. 23

[REV Mode]

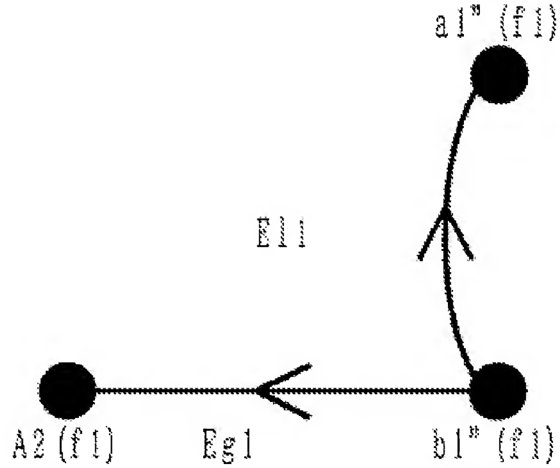


Fig. 24

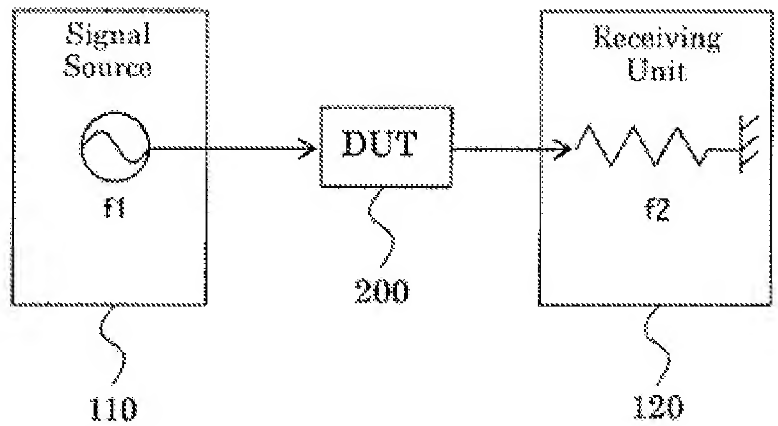


Fig. 25

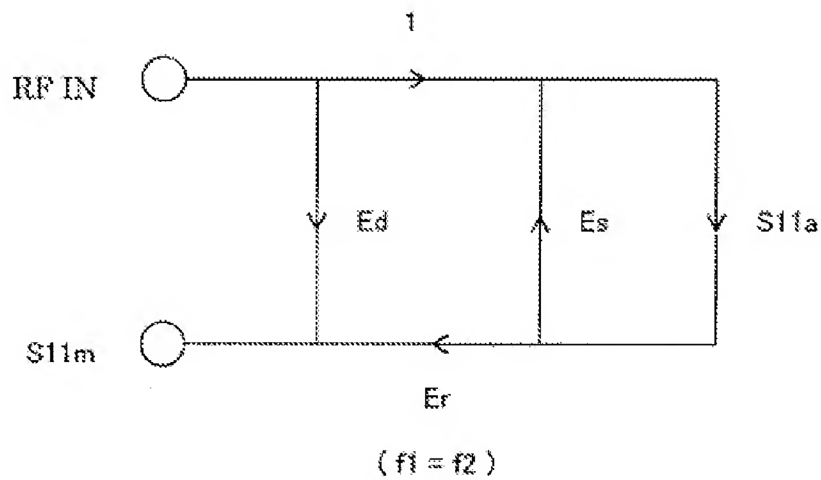


Fig. 26

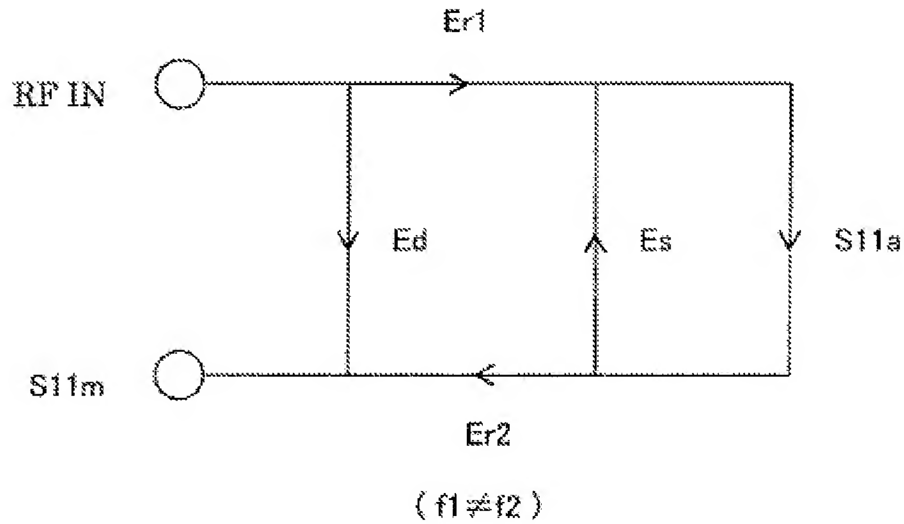


Fig. 27

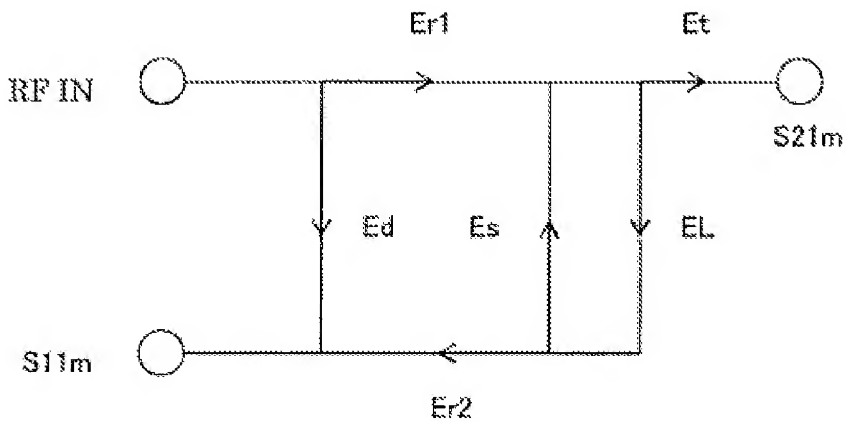


Fig. 28

[Title of Document] Abstract

[Abstract]

[Object] To enable the acquisition of the transmission tracking phase so as to enable the correction of error in a measuring system.

[Means for Resolution] A measuring system error factor recording unit 80 for recording measuring system error factors that occur independently of the frequency conversion by a DUT 2 is provided, and an error factor acquiring unit 90 is provided for acquiring a transmission tracking that occurs due to frequency conversion based on measurement error factors that are recorded in the measurement error factor recording unit 80 and based on a first coefficient and a second coefficient, through measuring the first coefficient and the second coefficient of a calibration mixer wherein the ratio of the magnitude of the second coefficient is constant, where a signal that is outputted from a terminal 2a expresses the sum of the product of the signal inputted into the terminal 2a multiplied by the first coefficient added to the product of a signal inputted into another terminal 2b multiplied by the second coefficient.

[Selected Drawing] Fig. 1

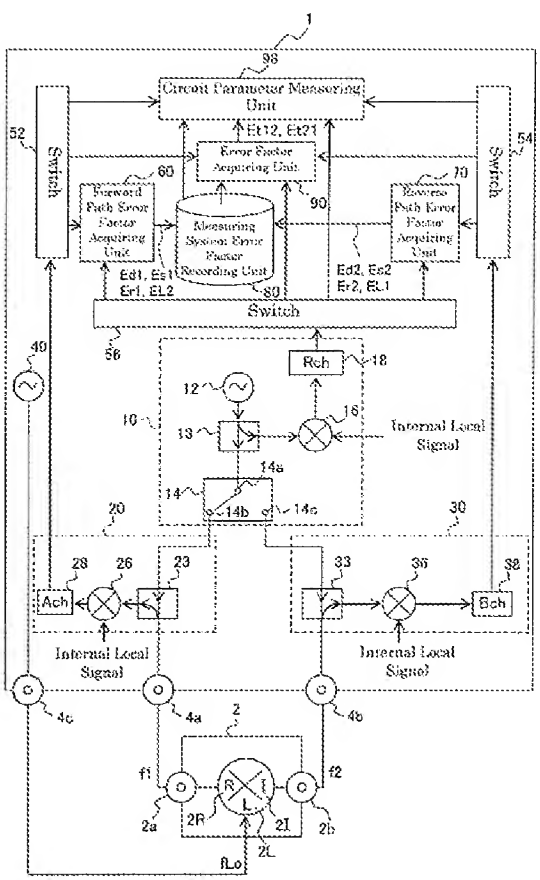


Fig. 1